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CONTENTS.

An Asterisk (*) denotes an illustrated article.

EDITORIALS—

Briefly Told 801

A Queer Phase in the Indianapolis (Ind.) Gas Contest—Notes.

CORRESPONDENCE—

As Illustrative of Differing Views 802

The Behavior of Cerium, Lanthanum, Neodymium, Praseodymium, Thorium and Zirconium Toward Organic Bases, by B. L. Hartwell 802

*Surveys for Electrolysis and Their Results, by Mr. D. H. Maury 804

A Survey of the British Coal Supply 807

The Bituminous Coal Trade, by F. E. Saward 808

An Object Lesson in Trust Formation 809

Back Pressu e in Purifying Boxes, by H. Hollweck 810

Experiments in Gas Explosion 810

Thermometers, by C. W 811

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 812

Street Lighting, St. Paul, Minn.—Mr. C. E. Chapman in Charge at Plattsmouth, Neb.—Mr. E. A. Pinckney in Charge at Sag Harbor, N. Y.—Mr. A. B. Frantz goes to Chambersburg, Pa.—Gas Works for Palo Alto, Cal.—Annual Meeting, Elizabethtown, N. J.—Queer Damage Suits, Brooklyn, N. Y.—In the Matter of the Relations of General Hickenlooper and the Cincinnati Gas and Electric Company—Changes at Vincennes, Ind.—A Story from Fall River, Mass.—Annual Meeting, Madison County, N. Y., Company—The Horse and His Keep—And Other Items.

The Market for Gas Securities 814

BRIEFLY TOLD.

A QUEER PHASE IN THE INDIANAPOLIS (IND.) GAS CONTEST.—The latest move in the remarkable contest now going on in Indianapolis, respecting the future of the Consumers' Gas Trust Company of that city, is shown in the fact that, at a recent public meeting (held in Masonic Hall, the 16th inst.) an organization, to be known as the Gas Consumers' League, was formed, and the General Committee named to carry out the purposes specified in the following resolutions that were adopted at the meeting consists of 42 prominent business men of the city—the action taken would seem to be clouded by doubt as to what is really meant, but the Indianapolis Gas Company is not likely to suffer, whatever be the outcome of the contest. We are indebted to Mr. James Somerville for our copy of the resolutions herewith reprinted:

"Believing that the Consumers' Gas Trust Company was organized for the public-spirited purpose of securing gas for the citizens of Indianapolis at the lowest possible cost; that its stock was placed in the hands of trustees as a sacred trust to enable them to protect the consumers of gas in the city of Indianapolis against the manipulation of the stock of the Company for private gain; and believing that there is now an organized scheme on the part of a few individuals to seize and hold for their own benefit the assets of said Company, which have been paid for by the people, and should in justice be used for the people by supplying gas at cost; and believing that several members of the present Board of Directors of said Company are interested in said scheme to divert said Company from its original purpose; and believing that the members of the Board of Directors, who are loyal to the public interests, deserve and are entitled to the active assistance, support and sympathy of all right minded people.

"Now, therefore, we, citizens of Indianapolis, in meeting assembled, do hereby form ourselves into an association, to be known as the Gas Consumers' League, which association shall have for its object the maintenance of said Consumers' Gas Trust Company for the benefit of the people of Indianapolis; and we hereby pledge ourselves to resist in all lawful ways, by our moral support and financial assistance, all schemes of every character intended, either directly or indirectly, to divert said Company from its original purpose; and, as the beneficiaries of said trust, we hereby petition the trustees and the directors controlling said Company to proceed with the steps required to supply the citizens of Indianapolis with manufactured gas to supplement the supply of natural gas, and to take its place when the natural gas supply is exhausted.

"In furtherance of our purpose, we hereby name and appoint the following citizens of Indianapolis to act as a general committee, with power to add to their number, to formulate a plan, to elect officers and committees, and to complete the organization to be known as the Gas Consumers' League."

NOTES—

MR. THOMAS H. CLARK, who has been acting as Superintendent of the plant of the Spencer (Mass.) Gas Company, will assume the management of the Clinton (Mass.) Gas and Electric Light Company on the 1st prox. Both Companies are controlled by the Boston, Light, Heat and Power Company.

LIBRARY OF CONGRESS NOV 23 1903

A CORRESPONDENT in Portland, Me., writing under date of the 14th inst., incloses the following: "People who are fond of filling their houses with century plants, rubber plants and all sorts of like vegetation which naturally belongs out-of-doors, should be cognizant of the danger which goes with such storage, for a gas plant recently exploded in the cellar of a Canadian hotel!"

THE business offices of the Watsonville (Cal.) Gas Company have been removed to commodious and easily accessible quarters in the Peck block. The change will be appreciated by the Company's customers and its office force as well.

ON January 1st the selling rates for gas in Duluth, Minn., will be: For lighting use, 90 cents per 1,000; for fuel and power uses, 75 cents.

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

As Illustrative of Differing Views.

WASHINGTON, D. C., Nov. 14, 1903.

To the Editors AMERICAN GAS LIGHT JOURNAL: I have read with interest Mr. Arthur Graham Glasgow's paper on "The Policy of Gas Enrichment (Illustrated by London Practice"), published on pages 712 to 728, in the JOURNAL for the 9th inst.

I confess to considerable disappointment on finding that the somewhat pretentious paper seems to be mainly an attack at long range on the policy of Sir George Livesey, who, like that other accomplished, brilliant and justly famous (in his time) American gas engineer, Charles Roome, dared to proclaim and maintain that the manufacture of illuminating gas of extreme high candle power was a costly mistake for producer and consumer alike. Even though the great improvement in artificial lighting—the Welsbach incandescent gas burner—had not been perfected in General Roome's day, it is a fact, however, that the General expressed his adverse convictions concerning very high candle power gas, which was then made only possible by the introduction of carburetted water gas; and it is now also Sir George Livesey, recognizing the value of the Welsbach improvement in the application of gas, proposed to put into effect methods by means of which consumer and producer could take advantage and derive the benefits of modern progress. Mr. Glasgow being engaged in the carburetted water gas business, and apparently not fancying what he seems to have regarded as detrimental to those interests, has stated his views at great length in his admirably put together paper, but he seems to entirely ignore *the fact* that there is no longer the one time perhaps desirability of very high candle power gas; since, when employing the Welsbach mantle, the gas (no matter what its initial candle power may be) must be reduced to virtually a non-luminous condition before it can be successfully used as an illuminator in any type of mantle burner.

That the Welsbach light is the most economical source of artificial light admits of no argument; denial thereof would be simply ludicrous. Then, why put an expensive illuminant into gas which will be better for the main purpose without it? One might as well deny the superiority of the electric trolley over the old horse car, or try to hold up the introduction of the former because some people might decline to use it, as to continue to go on with a no longer necessary high priced enricher, because there are people who will stick to the old style of gas burner.

Mr. Glasgow is always an interesting, and generally an instructive writer; but when he uses his great talents to uphold a policy which has been outstripped by the march of improvement, it is time to ask if disinterestedness is his main motive. That he is not forgetful to keep his end well up is seen in his statement of the "Approximate independence of labor," when the ratio is given as follows:

Carburetted water gas, 1; Coal gas, inclined retorts, 3 to 5; Machine work, 4; Hand work, 6 to 7.

It was well that Mr. Glasgow "hedged" a bit by basing his figures "on a scale of large operations;" because on most any other scale the results would not always be so flattering to water gas; as, for instance, with inclined retorts the ratio would in many cases be more like 1 to 1, than 1 to 3.5.

And so it seems to the writer that the whole of that paper, though read for and at the 31st Annual Meeting of the American Gas Light Association, was nothing but a shot at long range at certain common-sense British Acts, but with which Mr. Glasgow is not very well pleased. Advocating the manufacture of gas of a candle power higher than can be conveniently produced by fairly good gas coals[1] is *now*, in the view of modern improvements in artificial lighting, an apparently retrogressive step. Very respectfully, FREDERIC EGNER.

1. From the lines of Mr. Egner's general criticism on Mr. Glasgow's paper he seems to forget that low candle power water gas can be easily made.—Eds.

[Contribution to *Jour. Am. Chem. Soc.*, from the John Harrison Laboratory of Chemistry, No. 76.]

The Behavior of Cerium, Lanthanum, Neodymium, Praseodymium, Thorium and Zirconium Toward Organic Bases.[1]

By BURT LAWS HARTWELL.

An investigaiion along these lines seemed to promise well because of the success which Jefferson[2] met while prosecutiug a similar study with a limited number of aromatic bases. It was hoped that some organic base would be found, among the large number to be tried, which would lead to the separation of thorium and zirconium, or failing in this, that a method would be disclosed by which these two elements could be separated from cerium, lanthanum, neodymium and praseodymium.

Large quantities of thorium and zirconium nitrates were prepared from the mineral thorite and zircon. Numerous qualitative tests were made and the solvents for the bases were, in most cases, water and alcohol, or mixtures of these two, depending upon the solubility of the base. In some instances ether was added to advantage. Alcohol, above a certain strength, precipitated the thorium and zirconium nitrate solutions, so that this point had to be constantly considered during the testing. The salt solution was usually added in small quantities at a time to the solution containing a liberal amount of the organic base. Heat was applied, if precipitation did not occur in the cold. The solutions were not permitted to stand for long periods, as it was thought that differences which did not mauifest themselves readily, under ordinary conditions, would scarcely indicate the probability of practical quantitative separations.

The bases studied in this investigation were obtained from Kahlbaum. Those employed by Jefferson[3] were usually omitted here.

Reagents which Produced no Precipitate with Salts of any One of the Six Elements.

Benzylaniline.	*p*-Nitraniline.
Dimethylnitrosamine.	*p*-Nitrophenylhydrazine.
Dipropylnitrosamine.	Piperine.
m Nitraniline.	Succinimide.
o-Nitraniline.	Tetranitromethylaniline.
o-Chloraniline.	

Reagents which Caused Precipitates with Salts of all Six of the Elements.

Allylamine.	Isodibutylamine.
Benzylmethylamine.	Monoamylamine.
Bornylamine.	Monethylamine.
Camphylamine.	Monomethylamine.
Diamylamine.	Monopropylamine.
Dibenzylamine.	Neurine.
Diethylamine.	Normal butylamine.
Dimethylamine.	Normaldibutylamine.
Dipropylamine.	Propylenediamine.
Ethylenediamine.	Tetrethylammonium hydroxide.
Heptylamine.	Tetramethylammonium hydroxide.
Hexylamine.	Triethylamine.
Isobutylamine.	Trimethylamine.
Isotributylamine.	Tripropylamine.

Reagents which Precipitated only Thorium and Zirconium.

Benzidine.	Isoquinoline.
m-Bromaniline.	*a*-Picoline.
p-Bromaniline.	*p*-Toluidene.
p-Bromphenylhydrazine.	*m*-Toluylenediamine.
p-Chloraniline.	Tribenzylamine.

Reagents not Included in the Preceding Groups and whose Reactions are Mentioned upon Succeeding Pages.

m-Chloraniline.	*β*-Naphthylamine.
Diethylaniline.	Tetrahydroquinoline.
Hexamethylenetetramine.	*m*-Toluidine.
Monethylaniline.	*o*-Xylidine.
Monomethylaniline.	*p*-Xylidine.
a-Naphthylamine.	

The bases of the first and second groups were manifestly unsuited for the purpose in mind. Those of the third and fourth groups showing differences in deportment with the several elements under consideration were given mere particular attention, while those which were insoluble

1. From the author's thesis for the Ph.D. degree.
2. *Jour. Am. Chem. Soc* 24, 540.
3. *Loc. cit.*

in dilute alcoholic solutions were placed to one side. The following paragraphs record the observations made with the several bodies which seemed best adapted for quantitative separations.

Thorium and Zirconium with the Chloranilines.—The different behaviors of the chloranilines substantiate the views held regarding their relative basicity.[1] *o*-Chloraniline did not precipitate thorium or zirconium. *m*-Chloraniline precipitated zirconium in the cold, but with thorium, heat was required to produce precipitation, while *p*-chloraniline precipitated the solutions of both elements, even in the cold. Solutions of cerium, lanthanum, neodymium and praseodymium salts were not affected by these reagents.

Zirconium and Thorium with m-Chloraniline.—Much work was done upon *m*-chloraniline to arrive at the proper conditions in the strength of alcohol and temperature favorable to the complete precipitation of the zirconium solutions, and at the same time to leave the thorium salt unprecipitated. A solution containing equal parts of water and commercial alcohol was found most satisfactory. At a temperature of 60°–70°, this solvent containing *m*-chloraniline occasioned no precipitation in solutions of thorium nitrate, while in zirconium nitrate solutions it precipitated 0.0995 gram, 0.0988 gram, 0.0990 gram and 0.0988 gram of zirconium oxide, instead of 0.0995 gram obtained by ammonia or 0.0993 gram by direct evaporation and ignition. On repeating the experiment with a mixture of the thorium and zirconium nitrates, both elements were completely precipitated.

Thorium and Zirconium with Hexamethylenetetramine (Formin).—Formin in the qualitative tests showed a marked difference in behavior. Thus a thorium solution, after its addition, stood 42 hours at room temperature without the appearance of a precipitate. Upon adding the zirconium nitrate solution, both hydroxides were precipitated completely.

a- and *β*-Naphthylamine, *m*-bromaniline and *p*-bromphenylhydrazine precipitated zirconium solutions much more completely than those of thorium, but separations could not be effected by means of them. They reacted indifferently with the salts of cerium, lanthanum, neodymium and praseodymium. *o*-Bromaniline was not tried at all in this investigation.

In a solution of the nitrates of zirconium and cerium, *m*-chloraniline precipitated 0.0532 gram of zirconium oxide, instead of 0.539 gram obtained with ammonia water. *p*-Chloraniline precipitated 0.536 gram, *m*-bromaniline 0.0524 gram, and -naphthylamine 0.0533 gram. In the first three filtrates 0.0396 gram, 0.0400 gram and 0.0396 gram, respectively, of cerium oxide were obtained, instead of the theoretical 0.0389 gram. In using *p*-chloraniline with a solution containing twice the quantities of zirconium and cerium oxide given above, a very satisfactory quantitative separation resulted.

In precipitating a mixture of zirconium and cerium salts with *p*-toluidine, 0.1341 gram of zirconium oxide was found, while the theoretical amount present was 0.1347 gram. This same reagent added to a solution of thorium and cerium nitrates precipitated 0.1246 gram, 0.1236 gram and 0.1261 gram, instead of 0.1247 gram.

While monomethylaniline precipitated cerium solutions completely and apparently had no marked effect upon those of lanthanum, neodymium and praseodymium, the attempts at quantitative separations were fruitless. Diethylaniline precipitated cerium salts quite completely. The insolubility, however, of this reagent compelled the use of such large amounts of alcohol that serious difficulties arose. These were not overcome. A quantitative separation of cerium from lanthanum was made by means of tetrahydroquinoline. Two precipitations of the cerium were necessary.

o and *p*-Xylidine, as well as monethylaniline, precipitated cerium completely from its salt solutions. *m*-Toluidine seemed inadequate for this purpose.

p-Toluidine.—From observations made in the qualitative way, it appeared not improbable that *p*-toluidine might be employed to separate zirconium and thorium from lanthanum, neodymium and praseodymium. Accordingly, determinations were made in about 100 cc. of the weak alcoholic solutions, a moderate heat being applied to hasten the reaction. The precipitates formed were quite voluminous and somewhat gelatinous, especially in the case of zirconium, and well adapted for bringing down the accompanying element. On this account one reprecipitation was carried out in each case. The first precipitates dissolved readily in dilute nitric acid, especially if the solutions in the case of zirconium were not allowed to become too warm. The accompanying element was precipitated by ammonia from the combined filtrates. The ignition of the precipitates was conducted with free access of air, in a porcelain crucible usually, and the blast lamp used till constant weights were obtained. All of the weights, recorded in grams, are given in the condensed form below. The weights given as "required" were obtained by direct precipitation of the elements, separately, and blasting to constant weight, and represent the average of two closely agreeing results. The "combined" oxides represent the sum of the individual oxides. The results obtained in many cases do not agree well with the standard, but it was thought best to include all which, so far as known, were carried through without accident. Some minor differences in manipulation, such as varying the strength of alcohol, time of digestion, temperature and volume of solution, were made in different cases. These variations may have influenced the results in some instances.

Zirconium and Lanthanum.

Zirconium Oxide.		Lanthanum Oxide.		Combined Oxides.	
Found.	Required.	Found.	Required.	Found	Required.
0.1342	0.1341	0.0399	0.0409	0.1741	0.1750
0.1301	0.1341	0.0993	0.1023	0.2294	0.2364
0.1314	0.1341	0.1025	0.1023	0.2339	0.2364
0.1367	0.1341	0.0954	0.1023	0.2321	0.2364

Zirconium and Neodymium.

Zirconium Oxide.		Neodymium Oxide.		Combined Oxides.	
Found.	Required.	Found.	Required.	Found.	Required.
0.1349	0.1341	0.0413	0.0457	0.1762	0.1798
0.1439	0.1341	0.0973	6.1142	0.2412	0.2487
0.1372	0.1341	0.1102	0.1142	0.2474	0.2487
0.1446	0.1341	0.0952	0.1142	0.2398	0-2487

Zirconium and Praseodymium.

Zirconium Oxide.		Praseodymium Oxide.		Combined Oxides	
Found.	Required.	Found.	Required.	Found.	Required.
0.1317	0.1341	0.0420	0.0458	0.1737	0.1799
0.1344	0.1341	0.1099	0.1144	0.2443	0.2485
0.1312	0.1341	0.1129	0.1144	0.2441	0.2485
0.1304	0.1341	0.1015	0.1144	0.2318	0.2485

Thorium and Lanthanum.

Thorium Oxide.		Lanthanum Oxide		Combined Oxides.	
Found.	Required.	Found.	Required.	Found.	Required.
0.1254	0.1247	0.0407	0.0409	0.1661	0.1656
0.1222	0.1247	not det.	0.1023	....	....
0.1246	0.1247	0.1035	0.1023	0.2281	0.2270
0.1243	0.1247	0.1034	0.1023	0.2277	0.2270

Thorium and Neodymium..

Thorium Oxide		Neodymium Oxide.		Combined Oxides	
Found.	Required.	Found.	Required.	Found.	Required.
0.1254	0.1247	0.0464	0,0457	0.1718	0.1704
0.1232	0.1247	0.1146	0.1142	0.2378	0.2389
0.1242	0.1247	0.1142	0.1142	0.2384	0.2389
0.1242	0.1247	0.1129	0.1142	0.2371	0.2389
0.1248	0.1247	0.1118	0.1142	0.2366	0.2389

Thorium and Praseodymium.

Thorium Oxide		Praseodymium Oxide.		Combined Oxide.	
Found.	Required.	Found.	Required.	Found.	Required.
0.1253	0.1247	0.0471	0.0458	0.1724	0.1705
0.1214	0.1247	0.1147	0.1144	0.2361	0.2391
0.1238	0.1247	0.1160	0.1144	0.2398	0.2391
0.1246	0.1247	not. det.	0.1144	....	....

It will be noticed that the results with zirconium are not so satisfactory as those with thorium. This cannot be attributed to any difference in manipulation, for they were obtained under similar conditions, the usual practice being to carry on the 6 separations at one time.

A tendency on the part of zirconium to resist separation from other elements is again indicated here, This tendency is exhibited by its precipitation being retarded by the presence of another element, and by the fact that when once brought down it frequently is contaminated by that element. In the attempts to separate zirconium from thorium by *m* chloraniline, it was repeatedly noticed that conditions of digestion, sufficient to cause precipitation of zirconium by itself, were inadequate when thorium was present, and when the precipitate was thrown down it was badly contaminated with thorium. Similar observations were made when formin was used to effect their separation; in that case all of the thorium came down with the zirconium under conditions which failed to precipitate thorium when alone. It might be supposed that this peculiar behavior of zirconium would not be noticed upon passing from thorium to the more basic elements, but a number of the results obtained in connection with lanthanum and praseodymium show incomplete precipitations of zirconium, while neodymium was so inclined to come down with zirconium that a satisfactory separation could only be expected when all possible precautions had been taken to prevent it.

1. Van't Hoff's "Lectures on Theoretical and Physical Chemistry," Vol. II., p. 102.

The oxides obtained by ammonia from the filtrates weighed less in the separations from zirconium, than in those from thorium. If one attempts to attribute this difference to the greater solvent action of the filtrate from the zirconium, the only respect that suggests itself in which the two sets of filtrates differed is that they probably contained different amounts of the precipitant *p*-toluidine. More of this reagent was necessary to effect a precipitation in the solutions containing thorium than in those in which zirconium was present, and it is probable that in carrying out the two precipitations, as was done in each instance, considerably more *p* toluidine accumulated in the filtrates from the thorium. Sufficient attention was not given to this point while the determinations were being made to warrant an opinion as to the extent of its influence and it is merely offered as a possible explanation. As both the first and second precipitations were usually made from about 100 cc. of solution, the combined filtrates and washings, in which the precipitations by ammonia were made, were of considerable volume, and the question of the solvent effect of all this solution upon the precipitate produced by ammonia presented itself at the time of the determinations. The final filtrates were usually partially distilled, the bulk of the alcohol and ammonia being obtained in the distillate, from which the alcohol was recovered. More ammonia was repeatedly added to the undistilled portions to see if further precipitation would take place. In a few instances the entire solution was evaporated to dryness and the residue ignited and weighed. The weights obtained substantially made good the discrepancies between the combined oxxides "obtained" and "required," but as no blank determinations were made it was not proved that some of this may not have come from extraneous sources.

As previously stated, the recorded results were obtained by the use of the blast lamp till practically constant weights resulted. The writer is of the opinion, however, that errors may have occurred in this connection due to a constant composition not always being obtained, especially with lanthanum, neodymium and praseodymium. The weights obtained, by blasting the first two, were frequently 10 per cent. lower than those obtained by igniting over a Bunsen burner; there wass less difference with praseodymium. Hitchcock found that neodymium and praseodymium sesquioxides, by gentle ignition with free air access, gradually took on oxygen till the weights approximated those represented by the formula M_2O_7.

Herzfeld[1] speaks of neodymium oxide as having a blue color and assigns to it the composition Nd_2O_3, and again,[2] in an abstract from Shapleigh's investigation, mentions a suboxide as a gray powder and a peroxide as a dirty gray powder. The oxide obtained in the present investigation was invariably of light brown color resembling cocoa powder, after ignition with the Bunsen burner, and was usually changed to a light blue or light purple color by blasting. It was often necessary to pulverize and blast a long time before the bluish color was uniformly obtained; indeed, in some instances part of the oxide still retained the cocoa color even though by excessive blasting practically no change in weight resulted. In view of the inadequate and somewhat conflicting information concerning neodymium oxides, the composition of the oxide obtained in any particular case must receive careful attention. The change of color produced by blasting the lanthanum and praseodymium oxides was not sufficient to indicate a change in composition, but the weights, especially with lanthanum, were considerably reduced and the certainty of a definite composition should also be established in this instance.

The most that was attempted, during the present work, with any of the oxides, was to compare the weights obtained in the course of the analyses with those obtained by direct precipitation from the aqueous solutions by ammonia, and blasting until they were constant within a few tenths of a milligram. It would seem as though the oxides obtained in this manner would be of constant composition, but it is not improbable that small variations may have occurred and that lack of nice conformity may occasionally be attributed in part to this cause. The mechanical condition of the oxides previous to blasting was not always the same, and it seems not improbable that this fact may be of some importance where intense blasting is resorted to in order to remove the last traces of oxygen necessary to effect a complete transition from an oxide which, for example, is stable at the temperature reached by the Bunsen burner to one of a lower state of oxidation which may be the stable form at the temperature produced by the more intense heat of the blast lamp. Judging from the experience of Hitchcock, and from the fact that blasting invariably reduced the weights, it seems probable that, in the case of some of the elements, at least, an oxide of a higher state of oxidation was more stable over the Bunsen burner than over the blast lamp. Such behaviors have been noticed with some of the more common elements.

1. Chemie der Seltenen Erden, p. 63.
2. *Ibid.*, p. 122.

Surveys for Electrolysis, and Their Results.

[By Mr. D. H. MAURY, Peoria, Ills]

No problem which at present confronts those charged with the preservation of underground pipe systems is of more vital importance than the protection of these pipe systems from electrolysis. There are now before the courts at least 5 important electrolysis suits. In 3 of these suits the taking of testimony is as yet unfinished; the other two are now awaiting decision.

A large number of cities and corporations whose pipes have been seriously injured are anxiously awaiting the decisions in these cases before beginning similar actions. Under these circumstances, it is important that every pipe owner should know as much as possible of the progress of the damage, and of the actual conditions as they from time to time exist, in order to be thoroughly prepared for action when the time comes.

Naturally, the best method of getting this information is to secure the services of a competent and reliable expert to investigate and report; but a great deal may be accomplished by any intelligent water works' superintendent, having only a rudimentary knowledge of electricity.

It is hoped that this paper may give some suggestions that will be useful to such superintendents, whose duty it is to see that the pipes under their care are not destroyed by currents wrongfully allowed to stray upon them.

Let us assume that the objects of the survey are to trace, in a general way, the flow of current from rails to the pipes, along the pipes, and from the pipes back towards the rails or other return conductors; to prove the origin of, and responsibility for, this current; and to get some idea, necessarily approximate only, of the amount of damage caused by it. A map should first be prepared showing clearly the locations and sizes of all the mains, and the location of all street railway tracks and power stations, and of the return conductors leading back from the rails to the generators.

Instruments Required.—The instruments required for the electrical field work are few in number. There should be a Weston voltmeter, with 2 scales, the lower one reading to not less than 1 nor more than 5 volts at the limit of the scale, the upper scale reading 10 times as high. There should also be a millivoltmeter having 2 scales, the lower one reading to a maximum of 10 millivolts, and the upper one 10 times as high, or to 100 millivolts. Both instruments should preferably have the zero in the center of the scale, so that reversals may be read without switching.

The millivoltmeter may be converted into an ammeter by inserting between the terminals a shunt of proper resistance; but as a general rule it will be found more convenient to make determinations of current flow by the "drop of potential" method, to be referred to later.

In digging for pits in pipes, the blade of the ordinary pocket knife will sometimes close upon, and cut, the fingers, while the small handle will soon make blisters in the palm of the hand. A much better tool for this purpose can be constructed by having a blacksmith forge and temper a short stout blade, 1½ inches long, from a piece of an old file, and then set this blade firmly in a wooden file handle. A hammer and cold chisel will be needed for knocking the hard scale of the pipes, and a wire brush is sometimes handy, especially for cleaning wrought iron pipes. There should also, of course, be the necessary lamp cord for leads for the instruments; and, if the ammeter is used, suitably heavier cables will be needed.

The first step in the survey will usually be the reading of the difference of potential between hydrants and rails at various parts of the system. Two men, besides the observer, make a good working party for this purpose; and with a light wagon or surrey to transport men and instruments, from 25 to 40 such readings can be taken in a day. It is advisable to continue the observations at each point for several minutes, so as to note the extreme variations when cars are nearby as well as when they are not in the vicinity. These readings should at once be recorded in the note book, and transferred to the map at the close of the day, so that they may serve as a guide in laying out the work for the next day.

The measurements of difference of potential between hydrant and rail should be taken more with a view to getting a general idea of the normally positive and negative areas, so as to locate the best places for afterwards exposing the mains for inspection, than for any other purpose. They will, of course, indicate the territory in which the deepest pittings will be caused to mains and service pipes by the current which is permanently leaving the pipes to return to the rails or other conductors leading back to the power station. Such injury goes on more rapidly in the neighborhood of the power station, or where the return

conductors are connected to the rails; but it is by no means confined to this territory. For instance, it will be usually found that, at the extreme dead ends of car tracks, the mains will be strongly negative to rails when cars are using current nearby, and slightly positive to the rails at all other times. This means that in these outlying districts current is leaving the pipes, and pitting them just as in the districts near the power station, though less rapidly. The mains will also be pitted at every point in the city at which they happen to be positive to any other nearby piping system, or to the earth, or to anything adjacent; in short, which will offer any sort of conducting path from the mains back to the power station.

The voltmeter readings also incidentally throw some light upon other points, such as possible underground connections between rails and mains, the condition of track bonding in the various districts, etc., but unless supported by actual measurements of current flow, and inspection of the pipes themselves, they form insufficient evidence on which to base a suit, and their importance in this respect has been too often exaggerated. Unless the pipe system is unusually large, from 75 to 100 such readings will generally be sufficient for practical purposes.

Excavations.—The results of these observations having all been clearly platted on the map, the next step will be to study them, in connection with the location and size of the mains and the location of the rails and return feeders, in order to get some idea as to the best places to make excavations to expose mains for inspection and for measurement of current flow. These excavations should not be confined to any one district, but should be so distributed that each one may give results which shall as nearly as possible fairly represent the conditions in the territory surrounding the particular excavation. Some excavations should be made where the mains are normally positive to the rails, some where the rails are normally negative, and others where they are alternatively positive and negative, at what have been erroneously termed "neutral points." As a matter of fact there are no "neutral points," for the varying conditions of load in a street railway system cause the point at which there may be for the moment no difference of potential between mains and rails, to keep continually moving in and out, its travel frequently extending over a mile. One or more excavations should be made near the extreme outer limits of the car lines and mains, preferably where both the car line and the main on the same street are "dead ends." At such points the current in the mains can be clearly and conclusively shown to come from the operation of passing cars, as every movement of the needle can be seen to be directly coincident with the corresponding movement of the controller handle on the car.

One or more excavations should be made near the power station or return feeder taps leading thereto, to prove that the current in the mains returns to the power station; and it is well to carry on a series of readings at one of these points as well as at one of those at the outer end of the car track, from, say, 11 o'clock at night until the cars begin to run again next morning—an observer with compared watch being detailed to note the exact time when the last cars go into the barn and when the first cars leave it in the morning. In this manner the flow of current can be absolutely proven to be caused by the operation of cars from the generator at the power station. If there be two or more street railway systems operated from separate power stations, it will not be possible to identity the current in the center of the system as being produced by any particular generator; but it is perfectly easy to prove that some current from each generator does go to the pipes at the outer end of its trolley system, and that a corresponding amount of current does leave the pipes for that generator when the pipes are positive to the rails near the power station.

If the street railway companies attempt to protect themselves with the specious plea that, in order to collect damages from one of them when all are causing it, it is necessary to exactly apportion the amount of damage for which each is responsible, their defense will only react upon themselves; for it will serve to emphasize the fact that the only possible relief from the evil is for all of them to cease to cause the damage, which can only be accomplished by the complete removal of all of their current from the rails and earth.

Measurement of Current.—The drop of potential method of measuring currents is based on the well known Ohm law, $C = \frac{E}{R}$ or current, = electromotive force divided by resistance.

By this simple formula, if we know the electrical resistance of the length of a conductor between the two terminals of the millivoltmeter, and we read the difference of potential, or of electromotive force, we can calculate the current.

For convenience in measuring the current flowing in cast iron and wrought iron pipe, the writer has prepared the following tables·

Current Flow in Cast Iron pipe with 1 *Millivolt Drop. From Tests Showing Average Resistance per Pound per Foot* = .00144 *Ohm.*

Inside Diameter of Pipe in Inches.	Approximate Weight per Foot Without Bell.	Distance in Feet Between Points of Contact on Pipe.									
		1	2	3	4	5	6	7	8	9	10
		Current on Pipe per Millivolt Drop									
4	20	13 9	6.9	4.6	3.5	2.8	2.3	2 0	1.7	1.5	1.4
6	30	20 8	10.4	6.9	5.2	4.2	3 5	3.0	2.6	2 3	2 1
8	39	27.1	13 5	9.0	6 8	5 4	4.5	3 9	3 4	3 0	2.7
10	58	40 3	20.1	13 4	10.1	8 1	6 7	5 8	5.0	4 5	4.0
12	84	58 3	29 1	19.4	14 6	12 0	9 7	8.3	7 3	6 5	5 8
16	120	83.3	42 0	28 0	21.0	17.0	14 0	12 0	10 0	9 3	8 3
20	180	125.0	63 0	42 0	31 0	25 0	21 0	18 0	16 0	14 0	12 5
24	220	153 0	76 0	51 0	38 0	31 0	25 5	22 0	19.0	17 0	15 0
30	310	216 0	108 0	72 0	54 0	43 0	36.0	31 0	27 0	24 0	22 0
36	440	306.0	153.0	102 0	76 0	61 0	51 0	44 0	38 0	34 0	32 0
42	560	389 0	195.0	130.0	97 0	78 0	65 0	56 0	49 0	43 0	39 0
48	720	500.0	250.0	167 0	125 0	100 0	83 0	71 0	62 0	56 0	50 0
60	900	624.0	312.0	208.0	156.0	125 0	104 0	89 0	78.0	69.0	62.0

Current Flow in Wrought Iron Pipe With One Millivolt Drop. From Tests Showing Average Resistance per Pound per Foot = .000181 *Ohm.*

Inside Diameter of Pipe in Inches.	Approximate Weight of Pipe Per Foot.	Distance in Feet Between Points of Contact on Pipe.									
		1	2	3	4	5	6	7	8	9	10
		Current on Pipe per Millivolt Drop									
1¼	2.68	14.8	7.41	4.94	3.71	2.94	2.47	2.12	1.85	1 65	1.48
2	3.61	20.0	10.0	6.65	4.99	3.99	3.33	2.85	2.50	2.22	2 00
2½	5.74	31.7	15.9	10.6	7.94	6.35	5.29	4.53	3 97	3.53	3.17
3	7.54	41.7	20.9	13.9	10.4	8.34	6.95	5.93	5.21	4.63	4.17
3½	9.00	49.8	24 9	16.6	12.4	9.95	8.30	7.11	6.22	5.53	4.98
4	10 66	59.0	29 5	19.7	14.7	11.8	9.83	8.42	7.37	6.55	5.90
4½	12 49	69.1	34.5	23.0	17.3	13.8	11.5	9.87	8.63	7.67	6.91
5	14.50	80.2	40.1	26 7	20.0	16.0	13.4	11.5	10 0	8.91	8.02
6	18.76	104.0	51.9	34.6	25.9	20.7	17.3	14.8	13.0	11.5	10.4
7	23 27	129.0	64.3	42.9	32.1	25.7	21.4	18.4	16.1	14.3	12.9
8	28.18	156.0	77.9	51.9	39.0	31.2	26.0	22.3	19.5	17.3	15.6
9	33.70	186.0	93.2	62 1	46.6	37.3	31.1	26 6	23.3	20.7	18.6
10	40.00	221.0	111.0	73.7	55.3	44.2	36.9	31.6	27.7	24.6	22.1
11	45.02	249.0	125.0	83.0	62.2	49.8	41.5	35.6	31.1	27.7	24.9
12	49.00	271.0	135.0	90.3	67.7	54 2	45.2	38.7	33.9	30.1	27.1
13	54.00	299.0	149.0	99 5	74.7	59.7	49 8	42.7	37.3	33.2	29.9
14	58.00	321.0	160.0	107.0	80.2	64.1	53.5	45.8	40.1	35.6	32.1
15	62.00	343.0	171 0	114.0	85.7	68.6	57.1	49.8	42.9	38.1	34.5

Let us suppose, for example, that we wish to measure the current flow in a 10-inch cast iron pipe, of which a length of 8 feet is accessible. The surface of the pipe having been filed bright at 2 small spots 8 feet apart, one lead of the millivoltmeter is applied firmly to each spot, and it is noted that the needle indicates a drop of, say, 3 millivolts. Looking in the table for cast iron pipe, opposite the inside diameter of 10 inches, and under the distance between points of contact of 8 feet, we find that the current flowing on the pipe for each millivolt drop is 5 amperes. The actual drop noted was 3 millivolts, so that the actual current flowing was $5 \times 3 = 15$ amperes.

The table for wrought iron pipe can be used in exactly the same manner The weights given in the table for cast iron pipe are average weights per lineal foot of the plain body of standard cast iron water pipe without bell. The weight per lineal foot of such pipe as laid with bell would be about 10 per cent. greater. The weights for wrought iron pipe are taken from maker's catalogue. Care should, of course, be taken to so locate the points of contact of the millivoltmeter wires that no bell or joint is included between them.

As the work of examination of mains and measurements of current flow progresses, conditions, oftentimes entirely unanticipated, will arise; for stray currents, once released in the earth, are sad wanderers, and are frequently encountered where least expected. The investigator must then remember that the current will never fail to obey the laws of current flow, and will divide itself with unerring precision among all the paths offered to it, in quantities exactly proportional to the relative conductivities of those paths. If a large current bobs up where little or none is expected, or small currents are found where large quantities are looked for, it simply means that the investigator has been forecasting

results from wrong premises. If he keeps searching, his patience will probably be rewarded by the discovery of paths of unsuspected conductivity whose presence will entirely explain the wanderings of the current.

Field Notes.—Great care should be taken to promptly and accurately record everything of value observed, and to exclude all irrelevant matter from the notebook. The leaves of the notebook should be ruled in squares about 5 to the inch, and a rough sketch should be made of each point where the main is exposed. This sketch should clearly show the location, with the north at top of page, of the street lines, car tracks, if any, and pipes. There will usually be some specials or fittings exposed, and these should be sketched in and their sizes noted. The notes should record the date and hour of the obseevation, the character of soil and of pavement, if any; the condition of the pipes examined, the depth of the deepest pits actually found; the difference of potential, if measured, between pipes and rails; and the drop of potential along the given length pipe. Arrow heads in the sketch should show just where this drop was measured. The current can be calculated at the close of the day from the tables and recorded in the notebook. The notes should also show whether the pipes are positive or negative to the earth, or to any other pipes that may be exposed in the trench. Especial care should be devoted to examining joints for pittings or leaks. If lead or iron is visible as a redeposited compound in the soil, the fact should be recorded. While this list of points to be covered sounds long, practice will soon enable the superintendent to make very satisfactory sketches and field notes, and on the witness stand they will be indispensable. The notes should be carefully preserved, and it need hardly be added that to publish the results of the survey in advance of any legal action which might be based upon it would be a most unwise proceeding.

Damage Caused by Electrolysis.—The injuries caused by electrolysis may be divided into: (A) direct damages; (B), incidental damages.

Under the first head may be classed:

1. *The injury caused to the mains and service pipes by currents which leave their outer surfaces wherever they are positive to the adjacent earth.*

This injury goes on fastest in the territory near to the power station or to the points at which return feeders leave the rails for the power station As the pipes are at times positive to the earth at points remote from these centers, the injury from such outside pittings takes place, though usually at a slower rate, at points distributed almost all over the system. Many actual cases of serious pittings have been found miles from the power station, and at long distances from the rails. Every member of our Association has seen so many pipes pitted on the outer surfaces, that it is not deemed worth while to introduce any of the hundreds of available photographs showing this damage.

It is possible, by careful examination at many points properly distributed over the system, to make a reasonably fair estimate of the extent to which the mains and service pipes have been damaged by this class of pitting. The last two large piping systems examined by the writer showed an average depreciation, all over the entire system of mains, and due only to outside pittings on the mains, of between 21 and 23 per cent.

The depreciation from this cause can be expressed in percentages; but it must be borne in mind that the amount deduced from these percentages, if based on the actual original cost of laying the pipes, is by no means a fair measure even of the damage due to this class of pitting alone, for the cost of replacing single lengths of pipe piecemeal, as they break, is often many times the cost per lineal foot of laying the mains in the beginning. To the cost of the extra materials and labor required for the actual repairs, there is also to be added the labor of shutting off and draining the mains and the loss of water to the pipe owner, and as it is usually the case that mains are laid in advance of paving there is as a rule the added expense of repaving the street over the pipe, and the difficulty and danger of working under increased congestion of traffic in the streets. The percentage of injury to service pipes due to pittings of a given depth is naturally greater than that to the mains, because the service pipes are thinner.

2. *Injury caused by pittings inside the mains near the joints; or on the outside of spigot ends, under the lead at the joints, or inside the sockets of bells, over the lead; or on the lead itself.*

This class of injury is unquestionably the most serious, for it must occur whenever, in any part of the entire system, the mains are carrying current. There is no way of guarding against it, and no means of telling where it will occur first. The outside pittings in the body of the pipe may be seen by going to the expense of exposing the pipe. The joint pittings cannot be seen unless the pipe is cut open for inspection. The first result of these pittings is usually a small leak, which in sandy soil may run unnoticed for a long time. The escaping water finally cuts away the lead until the joint blows out, or else until the soil under the main is undermined so that the main settles and breaks. From the circumstances of the case, it is impossible to express in reasonably accurate figures the percentage of depreciation due to these joint pittings; but the writer has of late years found hundreds of instances of serious injury from this cause alone. Naturally the injury goes on most rapidly where the mains are carrying most current, and the territory in which the worst joint pitting is found is, therefore, roughly speaking, a zone or belt surrounding the location of power station and return feeders, but at a considerable distance from them. This is explained by the fact that mains gather current at their outer ends up to the point, where, at the instant, there is no difference in potential between mains and rails, and lose it from this point on towards the power station, thus carrying the greatest current at about this temporary neutral point.

A striking instance of such joint pittings is shown by the accompanying photographs, Figs. 1 and 2.

Fig. 1.

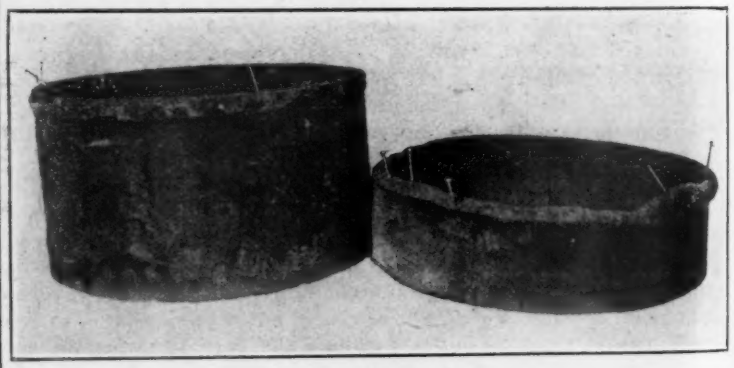

Fig. 2.

These photographs clearly show joint pittings on the spigot ends of 16-inch pipes which were removed in the writer's presence in the spring of 1900. There were in all nearly 1,000 feet of this pipe, which was about 2 miles from the power station, and which ran off at right angles to the track. It was always negative to the rails, and the current flowed along it from the spigot end of one pipe into the bell end of the next. No pits could be found anywhere on these pipes except near the positive side of each joint; but the spigot end of every single pipe was pitted, either on the inside or outside, or both, where the current left it.

The records of the water works of which this pipe formed a part, show that from 4 years after the street railways started to operate by electricity, and up to November, 1902, there were, in this stretch of main alone, 6 actual joint leaks requiring repairs, and 27 more similar leaks in the same main, nearly all in the same neighborhood. The records also show over 70 similar joint leaks in a 30-inch main, in the same system; 4 in a comparatively short 20-inch main; and 41 in mains of smaller sizes, for none of which can any other cause but electrolysis be assigned.

The extraordinary frequency with which the lead was being blown out of the joints, especially of the 30-inch main, which was, for over a mile, the sole source of supply to the city, finally caused the superintendent to put in special clamps designed to hold the lead in its place. After the lead of a leaking joint had been thoroughly recaulked, and the joint proven absolutely tight under pressure, a steel band or clamp

was bolted around the pipe in front of the lead in the joint, leaving a ½-inch space between the clamp and the face of the lead. This space was then carefully filled by pouring in lead, hardened by adding solder, so that unless the clamp slipped the lead in the joint had no chance to blow out. This device proved perfectly effective against the blowing out of the lead; but it could not prevent the continual electrolytic action in the joint, as several of these clamped joints have since leaked so badly as to require additional repairs. Fresh, deep pittings were also found on the clamps themselves.

Under the head of incidental damages may be included the following:

The loss of water; the destruction of pavements and of car tracks on the street; the settling of foundations of buildings, the flooding of basements, and damage to the goods stored therein, by the escaping water; cutting off of the water supply and fire protection from the territory affected, and the risk to lives and property of citizens as a result of any conflagration that might take place before the break could be repaired.

The actual damages to gas mains are exactly similar to those to water mains. The incidental damages resulting from gas explosions may possibly be even greater.

On December 11th, 1898, a 48-inch cast iron main burst in Brooklyn. Some estimates placed the loss, nearly all of which would come under the head of incidental damages, at several hundred thousands of dollars. While these estimates were probably excessive, the actual damage, notwithstanding the fact that no fires occurred in the territory served by the main while the latter was being repaired, was certainly enormous.

Some of the experts who examined the main attributed its rupture to electrolysis. Whether this was or was not, the cause is not to the point at present. The fact remains that every city whose mains carry currrent is exposed to the dangers of similar disasters.

Remedy.—These conditions call for a prompt, positive and absolutely effective remedy.

The street railway people have proposed scores of remedies. Among those which have been suggested are the following: Glass water pipes; wooden water pipes; laying service pipes inside of a rubber hose; wrapping the water pipes in some sort of alleged insulating cloth; painting the pipes with patent paints; making insulating joints in the mains; increasing the conductivity of the joints by bonding around them, and so on.

Apart from the fact that the pipe owner could hardly be expected to make over his plant in order to prevent its being damaged by the suggesters of these methods, the absurdity of all these remedies renders unnecessary further comment on them before any body of water works' men.

Forced to admit that it is impossible to keep the currents off the mains so long as the rails are used as return conductors, the street railway people have suggested many other remedies, to be applied by them with a view to reducing the damage to what they claim will be a negligible amount.

They say, in effect, to the pipe owner: "Let us alone, and we will cure your trouble. Your pipes have been breaking near the power station. We will rebond our tracks, and we will put in certain connections between your mains and return feeders that will reduce the difference of potential in the pipes in the district hitherto positive, so that no more pipes shall break there."

This proposition contains but one clause which can in any way benefit the pipe owner, and that is the rebonding of the rails. It is true that this would almost invariably be a first-rate business investment for the railway company, but as the pipe owner does not, or ought not to, wish anything but prosperity to the street car company, no objection ought on that score be raised to rebonding the rails.

But let us see how much actual benefit the pipe owner would derive from accepting this as a remedy for his injury.

Let us assume that the total conductivity of the rails as a path for the return current is represented by the number 50, and that the total combined conductivity of the earth, the water pipes, gas pipes, and all the other conductors buried in the earth, is represented by the number 100.

The current would then, broadly speaking, divide itself between the rails on the one hand and the earth and all the other conductors on the other, in the ratio of 50 to 100.

Let us next make the violent assumption that the street railway people actually do so improve their bonding, and the still more violent assumption that they actually so maintain its efficiency when improved, that the conductivity of the rail path is doubled and may be represented by the number 100; while the combined conductivity of the earth and of all the pipes and other conductors buried therein still remain the same, and are also represented by the number 100.

The result would be, again speaking broadly, that one-half of the current would go back by the rails, and one-half by all the other paths offered to it. The net gain to the pipe owner would be that the current now on his pipes would bear to the current which was there before the bonding was improved, the same relation which one-half bears to two-thirds. In other words, one-fourth of the current which the pipes were previously carrying would have been removed. Can any man claim that this would be reducing the injury to a negligible amount?

Every one of the other remedies embodied in the above proposal of the street railway companies involves some sort of connection between the pipes and the return conductors leading to the dynamo. These would also incidentally reduce the coal bill of the street railway company; but as before stated, the pipe owner should not object to them on that score.

The relief which it is alleged will accrue to the pipe owner by their use, is the diminution of potential of the pipes in the normally positive district, and the stopping of breaks where they have actually been occurring with greatest frequency.

It is true that by putting in these electrical connections between the mains and return conductors to the dynamo, the electrical conditions can be so changed as to reduce the potential of the pipes to some extent at certain points, though never to a negligible amount. But the inevitable result of every such connection is to increase the conductivity of the paths of which the pipes form a part, and to cause more current to flow on the pipes. This added flow of current will increase the injury at the joints all over the entire system. The effect of this joint injury has already been described, so that I need not dwell on it any further here. It will suffice to say that the net result to the pipe owner, who might consent to such remedies, would, in the long run, be far more serious and widespread injury than he has hitherto suffered. There is, then, but one real remedy, and that is the complete removal of the current from the ground.

If it could be shown in court that the present system of conveying water through the pipes was defective and dangerous; that the fluid conveyed leaked out at every joint, or that the pipes actually burst, interfering with traffic, destroying pavements, injuring street car tracks, endangering the foundations of neighboring buildings, or depriving business districts of fire protection until the breaks could be repaired, and if it could be further shown that, by the adoption of some other system of conveying this fluid, the owners of waterworks' plants could not only stop all this injury and danger, relief from which could be had in no other way, but that they could thereafter conduct their business at least as economically and profitably as before, no one will doubt that the court would order the pipe owners to adopt the safer system.

The analogy between this supposititious case of the pipe owners and the actual case of the railway companies seems to be complete in every respect. The current conveyed by the grounded returns of single trolley systems, does, in obedience to the law of fluid flow, leak off at every point of those returns at which the temptation presents itself, and this leakage, by injuring the water pipes, must inevitably result in exactly the above described injury and danger to the property of others.

That there is no known method by which owners of water and gas pipes can themselves prevent injury to their property from single trolley currents is now admitted by every engineer of competent experience and knowledge of the subject of electrolysis.

That the street car companies that cause the injury can, at moderate cost, so change their construction as to thereafter cease to cause the injury and to operate at least as successfully and economically as at present has been thoroughly proven by years of experience with the double trolley systems here and abroad. In all equity and justice, the street car companies should make this change of their own free will. It is the writer's firm conviction that to do so would be their very best business policy, and he believes that this conviction is shown by not a few of the fair-minded and far-sighted street railway men. If the street car companies do not voluntarily make the change, then they should certainly be compelled to do so.

A Survey of the British Coal Supply.[1]

The first report of the Royal Commission on the British coal supply has already been noticed in the *Journal;* and we now wish to draw the attention of those who are interested in the subject to the valuable stock of information contained in the Blue Book issued with the minutes of evidence so far taken by the Commissioners. The inquiry is not nearly finished; the uncompleted portion of the investigation covering the most important question of the reference—namely, the extent of the available coal resources of the United Kingdom. This is a long and difficult business, involving careful and exhaustive local inquiries, for which purpose the Commission has been split up into a number of district committees, who are being assisted by mining

1. *Journal of Gas Lighting.*

engineers and experts. The Commissioners are able to report favorably as to the extent of the co-operation they are receiving generally from coal owners and others interested in the coal mining industry; but this state of things is not universal. Still, on the whole, the inquiry is proceeding satisfactorily; and when the Commissioners complete their labors, the outcome should be a more trustworthy and comprehensive statement of the coal resources of the country than has ever appeared.

The names of some colliery engineers and managers well-known to gas managers appear in the list of witnesses, and a fair proportion of the evidence given relates to gas coal. The Commissioners were able to draw up a paper of questions to be addressed to witnesses respecting certain general points which are independent of the extent of the coal fields, yet bear directly on the extent of the available resources—such as the limit of depth in working, the minimum thickness of workable seams of coal, and the amount of waste in working. The present Blue Book deals almost entirely with these points. In regard to the question of the limit of depth in mining, the Commissioners had the benefit of hearing Mr. Joseph Dickinson, who was a member of the 1866 Commission, which reported during 1871. It was found by this Commission that the limit of workable depth might be taken at 4,000 feet. Mr. Dickinson gave some interesting evidence supplemental to the data known to the former Commission. The deepest coal workings he has been in are those of the Pendleton Colliery, and the Moss Colliery, Audenshaw, having made observations in these pits at depths exceeding 3,000 feet. The former ranks as the deepest mine in the kingdom at the present time. The seams worked are the Rams seams, varying in thickness from 2 feet to 6 feet. The temperature at a depth of 2,955 feet in 1890 was: Dry bulb, 87°; wet bulb, 77°. The heat at the face is a matter of the ventilation, also of the pumping and sprinkling. With large shafts such as are put down now, and modern working appliances, Mr. Dickinson did not think great depth matters very much to the colliers. Speaking of spontaneous combustion, the witness stated that in storing coal liable to this, it is found best to build the heap to the required height and then tip over. Being pressed by the Commissioners, Mr. Dickinson would not say that the former limit of 4,000 feet might not be increased to 5,000 or even to 6,000 feet. On the point of the thickness of seams, Mr. Dickinson has known cannel coal of 8 inches worked. Seams of 24 to 28 inches in thickness are very extensively worked in Lancashire. He regarded 12-inch seams as workable.

Further evidence relating to the Pendleton Colleries of Messrs. Andrew Knowles & Son was subsequently given by Mr. Henry Bramall. In July, 1902, with the temperature of the air at the surface 64° F., the temperature at the bottom of the workings, 3,483 feet below the surface, was 92.5°. The temperature of the rock bottom, taken in a bore hole in the floor, was 100° F. Mr. Bramall was unable to state any general ratio for the rise of temperature with depth, because it varies so much. The Rams seam, now being worked in the Pendlebury Colliery at a depth of about 3,500 feet, is from 5 foot 1 inch to 5 foot 5 inches thick. It has both a covering and a bedding of soft stuff which can be scraped out, when the pressure of the rock forces the coal out by itself in large blocks—there being no blasting or picking required. In the coronation procession, the firm sent a solid block of this coal, weighing 25 cwt., which was got in this way from a depth of 3,500 feet. This is a very fine house coal. Mr. Bramall committed himself to two generalizations—that the deeper the mine the drier the atmosphere; and the higher the rate of the colliers' wages the less they will produce. He was reluctant to admit the practicability of getting coal—particularly gas coal, which has to be sold at a comparatively low price—from greater depths than 4,000 feet. The difficulty chiefly lies in the temperature and pressure—the former affecting the men's ability to get the coal, and the latter closing the roads as fast as they are cut. Mr. Bramall was complimented by Lord Allerton, the Chairman, on the lucid way he gave his interesting evidence.

Mr. J. Gerrard, an Inspector of Mines, with experience in the East and West Lancashire and the Yorkshire districts, thought the prospects of coal cutting machines better with regard to good house coals than for gas or coking coals. The proportion of small is not of so much consequence with the latter. He also stated that thin seams, down to 10 inches, are workable if the coal is of good quality for the house or gas, or really good for the steam classes. The question is a commercial one. Mr. Gerrard was disposed to think that Mr. Bramall had overrated the difficulty of keeping roads open at great depths. He mentioned the cases of the Bradford Colliery, Manchester, which is about to sink a shaft from the surface to 880 yards, from which point it will draw coal. Ashton Moss is another very deep pit. There are now several collieries working at a depth of upwards of 2,000 feet, whereas when the former Commission took evidence, there were none. Mr. Gerrard agrees that the deep mines have a dry atmosphere; but the degree of comparative humidity varies a good deal. The air in the deep Bradford mine is not much drier than at the surface. Mr. Gerrard holds that experience has proved the practicability of winning coal from a depth of 4,000 feet, but he will not say anything about greater depths until the fact has been established. Conditions vary so greatly that he would not attach much importance to the opinions of even eminent men until coal has been actually worked at 4,500 feet vertical depth. There is no insuperable objection to such deep sinking or working. Mr. Henry Hall, Inspector of Mines for the Liverpool and North Wales district, spoke to the subject of depth and temperature. Two of the deepest pits in the district are the Alexandra and the Abram Collieries, Wigan. The former is 775 yards deep at the shaft to the famous Arley seam, 3 feet 10 inches thick. The air in the mines is very dry; the difference between the dry and wet bulbs being as much as 14° at 91° F., which is considered hot, though the overlookers believe the men could stand 10° more. The coal is not injured by crush, but takes a flaky form. It is cheaper to work than seams at half the depth. Mr. Hall admitted that the depth of colliery workings had increased by 500 or 600 feet during the past 25 years; and he could not say positively why the same process should not go on indefinitely, except for the increase of temperature, which in the Arley seam is in excess of the usual hypothetical rise.

Mr. John Nevin, of Mirfield, spoke to the working of a seam of gas coal, clean and tender, 2 feet 6 inches thick, the whole of which was got out because it had no dirt in it. Generally speaking, a good gas coal can be profitably worked as thin as 2 feet. Men require to be brought up from boyhood to this kind of work. Mr. J. R. Bennett, speaking for the Somersetshire field, thought there was no evidence for limiting the depth of working to 4,000 feet; but he would bar all seams under 12 inches thick. It is interesting, as bearing upon the point of availability, that Mr. Bennett's Company only find 5 out of about 60 seams in the Bristol coal field worth working. Another Somersetshire colliery manager, Mr. W. Steart, put the limit of working depth at 5,000 feet. A witness from the other end of the country, Mr. R. Martin, of the Niddrie Collieries, Portobello, agreed that there is nothing to fear in a depth of 4,000 feet. He is working at 2,448 feet already, raising cannel and gas coal. It came out, as common ground with most of the witnesses, that the depth assists the collier to get the coal. Some valuable evidence concerning the cost of very deep mining was given by Mr. H. W. Martin, of Dowlais. He saw no difficulty in raising coal from depths exceeding 4,000 feet, but the cost will probably increase in proportion to the depth, largely by reason of the pressure. Important evidence on the subject of coal leases was given by Mr. Thomas Ratcliffe Ellis, the Solicitor and Secretary to the Mining Association of Great Britain. One cannot go into all the points covered by this Blue Book; but perhaps the nature of its contents has been explained sufficiently to show the importance and interest of the subject matter.

The Bituminous Coal Trade.

By F. E. Saward, in *Iron Age*.

Whatever may have been the position of the consumer during the winter of 1902-3, he has had the best of the coal situation during the past 5 months. By the consumer is meant that large class making use of fuel for steam or general manufacturing purposes. The very high prices of all grades during the winter were caused by the short supply of anthracite. At times up to $5 a ton at the mines had to be paid for bituminous coal, and some of it of indifferent quality at that. This extraordinary condition of affairs could not be expected to continue for any length of time after the production became normal. It was the expectation, however, among some of the producers of soft coal at the mines supplying the trade east of the Alleghenies that a better price than ruled in 1902 could be had. They were led on to this idea by the increased rate of tolls to be paid to the carrying companies, and also the increased wages paid for mining from April 1, both these items, perhaps, being largely due to the very high figures of the preceding winter. Therefore a schedule was formulated which gave the shippers of soft coal quite a generous advance over the rates of 1902. But consumers took the coal sparingly under these circumstances, and the shippers who had the lower grades of coal were more numerous and more active in pushing for business. This resulted, of course, in the higher priced coals being neglected to a degree. There was also a great deal of what is known as shipping "on the market." This was another benefit to the buyer, and it was duly and fully taken advantage of. The course of the soft coal business

has, therefore, been not what the shippers had looked for, and some tonnage had been disposed of at less than cost of production. A great deal of tonnage was placed during September on the basis of $1.10 per ton at the mines, as against an agreed on price of $2 per ton.

In view of all this, there has recently been an effort to ameliorate conditions from the producer's standpoint. The whole situation has been thoroughly discussed, and the upshot of it all is that there will be temporary shut-downs at the collieries in order to bring values up to something like the scale originally proposed, for the two items of increased tolls and wages must stand. The cessation of operations will not seriously affect the higher grade tonnage, as that had been curtailed before by the increased efforts of owners of the cheaper coals to put their stocks into the market; but it will tend to eliminate very largely these cheaper grades and reverse the position, the producer being independent and not compelled to accept the price offered by the purchaser in order to relieve cars or vessels. One may be able to get all needed supplies, but hardly at the abnormally low figures which prevailed for some tonnage which was marketed during August, September and October. An agreement to work only 4 days a week, and hold prices at $1.50 at the mines, is now in order.

The prices set at the opening of this year's contract season were as follows:

At Greenwich, Philadelphia, f.o.b., Clearfield, Beech Creek, Meyersdale, Fairmont and Davis small vein, $3; Cumberland and Elk Garden, $3.35.

At Baltimore, f.o.b., Clearfield, Beech Creek, Meyersdale, Fairmont and Davis small vein, $2.93; Cumberland and Elk Garden, $3.30.

At Newport News, f.o.b., Chesapeake & Ohio, $3.15.

At Norfolk, f.o.b., Norfolk & Western, Pocahontas, $3.15.

How they have been more honored in the breach than in the observance every buyer of coal knows only to well from the opportuniites offered as above noted.

The Bituminous Coal Tidewater Association, whose members had practically determined to make a reduction of from 50 to 60 cents a ton in the prices fixed last April, have reconsidered that action. The programme as revised is for the various operators in the Association to maintain the April price as far as possible. To make an official reduction from the April prices, it is said, would seriously affect existing contracts, which under their terms require that any reduction will apply equally to any portion of the contract uncompleted at the time of such reduction. Furthermore, it is argued that any reduction in the prices made now would have to be borne entirely by the operators, as both the wage scale and the freight rates are fixed for the year, and no concession in that direction can be expected. By waiting until next April, when the 1904 prices will be fixed, it is confidently believed that, unless conditions change very materially, both the railroad and labor situation will co-operate toward lower prices. In the meantime if the operators stand firm on the basis as outlined it will mean an advance of from 50 to 60 cents a ton over the summer's open market prices. So far as market conditions are concerned it looks very much as if the matter of price has little or no effect, and it is questioned by some whether an official reduction would be sufficient to galvanize life into a trade that has been dull and almost lifeless all summer. The relief must come from the reduction of the available tonnage.

With the approach of cooler weather there will be a much greater use of soft coal for other than industrial purposes, and this will tend to stiffening of values; there is a large area of country where bituminous coal is used for heating purposes, and this takes away a lot of coal that otherwise would be thrown upon the market for use in industrial purposes. Prices during the past week have kept at $2.40 and $2.50, at New York harbor, with about $2.65 f.o.b. at Hampton Roads' points; the latter ports are said to be very much busier than they were a fortnight ago. Conditions in the all rail trade are little changed, a curtailment of shipments to one place being offset by an increase to another. Some small reductions are reported in the prices named at certain all rail points, but these reductions do not seem to have any very great effect in increasing the tonnage wanted.

The New England manufacturer is vitally interested in the continuance of "free coal;" the duty was suspended on January 15, 1903, for the term of one year, owing to the short supply of American coal of all kinds during last winter; the receipts at Boston alone amounted to 790,000 tons in the first four months of this year, and while perhaps the duty did not figure very strongly, the possibilities of foreign supplies were a feature not to be disdained. Nova Scotia will no doubt continue to send a large tonnage to the New England ports, as she has always done, for there are many good coals mined there, and the cost is not much beyond that of American coal, duty or no duty. As the conditions in American mining change, we look for an extended trade to upper Canada, to replace the loss in New England, inasmuch as nearly all of the increase in the importations of coal in the present year under the removal of rebate of duty authorized in January have been from the United Kingdom, the total increase amounting to 1,140,969 tons. Meantime the exportation of coal has increased from the United States in the nine months ending with September, 1903, to 6,314,189 tons, against 4,720,330 tons in the corresponding months of last year, an increase of 1,503,859 tons, mainly to Canada and Mexico.

The reduced prices for American soft coal offer us again the opportunity for foreign shipments to European ports—suspended during high prices and heavy demand at home—if vessels could but carry coal at a fair figure. This probable competition is made much of by the coal operator of Wales, who tells his employees "there is no shutting out the fact that the exports of other countries become stronger and stronger rivals to the South Wales coal every year." It is only a short time ago that the Cunard liners took sufficient bunker coal from Wales for the outward and homeward voyages. They do not do so now, the return voyage being made—it is said with good results—on American coal. Vessels from India, China, Japan and other countries in that direction make the return voyage to the Suez canal with Australian or other coal, according to the country from which they sail, and the establishment of depots of American coal would give us that trade. The exports of Welsh coal to Rio, La Plata and other ports in South America are, without question, declining, while the exports from America are increasing. Truly has it been said that the whole of the coal fields of America, Australia, etc., are, compared with the South Wales coal field, comparatively new as to their development, and the quality of the coal has been proven to be good, and the future coaling stations of the world will carry a supply of other than Welsh coal.

An Object Lesson in Trust Formation.[1]

We have recently been treated to some very striking examples of the evils that follow, with the certainty of Nemesis, upon the formation of American trusts. For combination to produce economically, and so enable a concern to meet competition, there is much to be said, and it has been said from time to time in these columns. But combination of the sort that has grown to such an extent in the United States, during the last 4 or 5 years, carries in it the seeds of its own dissolution. A "combine," embracing a considerable proportion of a whole industry or branch of industry, may contrive to pay dividends during periods of trade activity; but as soon as the tide turns, and, in order to attract consumers, it is compelled to make concessions from a level of prices artificially high, it begins to feel the consequences of its inflated capitalization, and of its inadquate appropriations for depreciation of plant and for other purposes incidental to its business. This is the experience of the Steel Trust, which, since we had occasion to refer to it lately, has been forced to reduce its dividend by one-half—to 2 per cent. per annum—to be followed, no doubt, by the "passing" of the dividend altogether before long—and to close down some of its works. The surplus shown in the balance sheet is $29,348,000, and if it be genuine, it follows that the directors, had they so chosen, could easily have paid the usual dividend. It is admitted, however, that in deciding upon the reduction they were looking into the future, and considering the probable effect upon the company's earnings of the falling off in the iron and steel business, which has been in progress for some months, and that reasonable regard for conditions, as they now are, and as they are likely to be in the near future, did not warrant the payment of more than half the usual dividend. This is an interesting acknowledgment, and it proves what we have said all along—that the condition of the American iron and steel trade since the revival was abnormal, that an estimate of average profits based upon the results of this period was quite unwarranted, and that, in short, trade conditions on a series of years would necessarily fail to show even a fair return upon the capital—very heavily "watered"—employed in it. This has proved to be the case, not with the Steel Trust alone, but with virtually every one of the scores of consolidations registered since the boom started.

Since the recent disclosures concerning the formation of the Shipbuilding Trust—which must not be confounded with that other dismal failure, the North Atlantic Shipping Trust—the distrust in "combines" has become very marked and quite general. In one day the market capitalization of a dozen of these concerns fell off to the extent of £8,000,000. Luckily, we in this country have a direct interest in very

1. *Engineering*, London.

few, but the developments are singularly interesting to the onlooker who persisted in the old-fashioned belief that economic laws would prove too much for the trusts, while the company promoters were swearing that these vast incorporations were really a public benefit if properly regarded, and the ultimate development of true economics. All the trusts, one may hope, are not such flagrant examples of bad promotion as the Shipbuilding Trust, but the difference between them is one of degree and not of kind. The particular concern went into liquidation, and the revelations in the courts the other day throw a lurid light upon the business. It is asserted by the receiver that Mr. Schwab, late of the Steel Trust, secured control of the Bethlehem Steel Works cheaply, and, with the aid of Messrs. Morgan, passed them on to the Shipbuilding Trust at a high figure, as represented in the stock of this last concern, which same stock, amounting to the equivalent of £4,000,000 sterling, was to be sold before any other holdings. The Morgans have denied that they had any hand in the formation of the Shipbuilding Trust, but it is beyond question that they were concerned with Mr. Schwab in the sale of the Bethlehem plant. It is Mr. Schwab, however, who, if the allegations made are true, comes badly out of the business. The charge of false representation is made against him; the directors of the trust were his dummies; and it is asserted that he caused John W. Young, who acted under his instructions, to propose to the directors of the shipbuilding company to buy the Bethlehem plant for $30,000,000. The directors of the shipbuilding company, "who acted solely under Mr. Schwab's instructions and directions," undertook to carry out the terms of the transfer, and the $10,000,000 bond issue was made, with the New York Security and Trust Company as trustee. The $20,000,000 of stock was also turned over to Mr. Schwab. The only consideration was the shares in the Bethlehem Steel Company, which Schwab and Young well knew were not worth more than $7,500,000. It is not necessary for us to go further into this unsavory case. It is exceptional, no doubt, but the spirit of greed and recklessness which marked the formation of the Shipbuilding Trust is visible in every other combine formed in the last few years in America. Fundamentally the trusts are rotten and overweighted with capital, which is causing them to topple over.

Evidences of a further falling off in trade are multiplying almost daily. Extensive reductions are being made in the track and shop forces of the New York Central, the Lake Erie and Western, the Lake Shore and Michigan Southern, West Shore, and other affiliated Vanderbilt roads; and, in fact, a similar cutting down of expenses is being put into effect on the principal railroads of the country, including the Southern Pacific. One of the Vice-Presidents of the New York Central said the other day that he looked for further cutting down, because a material decrease in business was anticipated; and he added: "That is but natural when steel mills are closing down, and in the present condition of the building trades, owing to strikes. We understand that the output of pig iron will be reduced 25 per cent. That means 25 per cent. less coke, and also 25 per cent. less business for us." By reason of this condition, the leading railroads of the country, which are good customers to the Steel Trust, and other companies, are cancelling their orders for rails, locomotives, and other equipment. The Trust will retaliate upon the railroads, for it proposes to make demand upon the railroad companies for a material reduction in freight rates upon finished products.

Back Pressure in Purifying Boxes.[1]

[A paper read by HERR HOLLWECK, Munich, at the last meeting of the Bavarian District Gas Association.]

At Munich, in order to reduce the amount of charging and emptying the purifier boxes, 1½ per cent. of air is added to the gas. One cubic foot of purifying material is found to purify 7,000 to 8,000 cubic feet of gas; the material used being an admixture of old material with a proportion of fresh. The long period of exposure to the gas results in the formation of a hard crust, which induces a more and more rapidly increasing back pressure. This in its turn tends to induce failure of the hydraulic seal, and then the boxes have to be prematurely emptied out. These difficulties have been got over by splitting up the stream of gas, principally through alterations in the inlet and outlet. The boxes have 4 grids, and the inlet is between the second and the third of these, while the outlets are two, between the top grid and the cover and between the bottom grid and the bottom of the box. These outlets are both into a pipe of special form. The upper outlet lets the gas into this pipe at its top, where the pipe is pinched to one-half its full clear cross section; then the pipe descends to the level of the bottom of the box, where it is pierced to receive the other half of the gas from the lower outlet. By this means each half of the gas gets the full benefit of the full area of the box, and the back pressure is materially reduced without affecting the certainty of removing the sulphur. It was at first apprehended that there might be some inequality between he toutflow of gas from the upper and the lower part of the box; but in practice no such difficulty was experienced.

1. *Gas World.*

The following tests were made with divided and undivided gas streams respectively, in systems of 3 boxes with 4 trays each, each of 40 square meters, the filling being identical in all cases:

Gas per Hour. Cubic Feet.	Nominal Velocity. Inches per Second.	Average Back Pressure per Box. Inches.	Back Pressure of the 3 Boxes. Inches.
A. Gas divided as above:			
52,620	0.2120	0.932	2.796
49,795	0.2008	0.920	2.760
48,382	0.1948	0.892	2.676
47,323	0.1908	0.800	2.400
38,494	0.1552	0.668	2.004
32,137	0.1296	0.508	1.524
30,371	0.1224	0.500	1.500
25,427	0.1024	0.412	1.236
24,721	0.0996	0.400	1.200
22,955	0.0924	0.372	1.116
19,777	0.0796	0.280	0.840
17,658	0.0712	0.264	0.792
16,245	0.0652	0.240	0.720
15,539	0.0624	0.220	0.660
9,535	0.0384	0.132	0.396
B. Gas sent through all trays as usual:			
49,442	0.3888	2.972	8.816
47,676	0.3748	2.920	8.760
45,910	0.3608	2.720	8.160
39,907	0.3132	2.480	7.440
36,728	0.2888	2.308	6.924
28,252	0.2220	1.840	5.520
26,487	0.2080	1.624	4.860
24,015	0.1888	1.440	4.320
21,896	0.1800	1.240	3.720
19,070	0.1500	1.200	3.600
18,364	0.1444	1.040	3.120
15,892	0.1248	0.800	2.400
14,833	0.1164	0.800	2.400

The back pressures per tray are half the back pressures per box under A above, and one-fourth those under B. The data under A show that the danger of breaking the seal is materially reduced, and a comparison of the figures indicates that it would be quite within reason, on the basis of the principle of construction described, to put 6 trays in each purifier, and to make the purifier boxes correspondingly higher.

Experiments in Gas Explosion.[1]

[By L. BAIRSTOW, A.R.C.Sc., Wh.Sc., and A. D. ALEXANDER, A.R.C.Sc., Students under Professor Perry, F.R.S.]

The experiments were made on mixtures of London coal gas and air, in a cylinder 18 inches long and 10 inches in diameter, in an attempt to find the cooling action of the cylinder walls on the maximum pressure reached by an explosion. Diagrams are drawn on a uniformly rotating drum by an ordinary indicator.

Considerable differences in the values of the maximum pressure, obtained from explosions of the same mixture under apparently similar conditions, having been noticed and attributed to imperfect mixing, a series of experiments was carried out to determine the possible magnitude of the differences, and the precautions necessary to prevent their occurrence.

The mixtures were prepared by pumping a partial vacuum in the cylinder, admitting a measured volume of gas, and finally letting in air to bring the contents of the cylinder to atmospheric pressure. The ratio of the volumes of gas and air in all these mixtures was .225. Gas and air were admitted at the same opening in the center of the upper cylinder cover.

Maximum pressures were obtained varying from 59 pounds per square inch up to 92 pounds per square inch, this last highest pressnre

1. Read before the British Association, Section G, at Southport.

being reached with a mixture that had been left in the cylinder for 17 hours. On one occasion, when the gas was admitted very gently into the cylinder, the mixture would not explode even after 20 hours. More air was pumped in very rapidly at the end of that time, after which the explosion reached a high pressure. Another mixture, allowed to diffuse for 47 hours, gave an immediate explosion with a maximum pressure of 39 pounds per square inch.

By pumping a considerable vacuum, and after the admission of the gas, allowing the air necessary to restore atmospheric pressure to enter very rapidly, a fairly effective mixing was obtained, and pressure very near the maximum were invariably obtained.

Mechanical stirring was now tried, and a pressure of 93 pounds per square inch resulted. Two experiments on mixtures in which the ratio of the volume of gas to that of air was .215 gave pressures of 90 pounds and 88 pounds per square inch after stirring, whilst refusing to explode before that operation.

In the case of mixtures having about 1 volume of gas to 5 volumes of air, small variations in the proportion have very little effect on the maximum pressure.

All later experiments have been confined to mixtures at an initial gauge pressure of 19.6 pounds per square inch, the mixture being now made by pumping a partial vacuum (measured on a mercury gauge), admitting gas to bring the contents of the cylinder to atmospheric pressure, and finally pumping in air rapidly until the pressure reaches 20.7 pounds per square inch. The mixture being then allowed to escape through the firing tube until the pressure fell to 19.6 pounds per square inch. Any errors due to incomplete mixing were now so small that they have not yet been recognized.

Having practically eliminated this source of error, it became possible to make more direct experiments on the cooling effects of the cylinder. In order to vary the duration of the explosion, and therefore the amount of cooling before the maximum pressure was reached, an alteration was made in the method of firing. This alteration consisted of placing a telescopic tube over the spark (the latter always being at the top of the tube), so that the flame traveled down the whole length before communicating with the cylinder.

The time of explosion for the richest mixture (.171 of gas to 1 of air) was increased from .035 second with a firing tube 8 inches long to .1 second when the tube was 2 inches or 16 inches long, and no loss of pressure was noticed as a consequence.

With a weaker mixture (.097 of gas to 1 of air), the duration of explosion varied from .24 second to 1.8 second, with resulting pressures of 185 pounds per square inch for the quick explosion and 118 pounds per square inch for the slow one. Intermediate experiments gave results in which the higher pressures corresponded with the quicker explosions.

The type of result occurs in all mixtures, but the magnitude of the pressure difference diminishes rapidly as the mixture gets richer, becoming very small when the ratio of the volumes of gas and air reaches 1:8.

This lowering of pressure is the difference between the loss due to cooling and the gain due to less dissociation of the carbon dioxide. Trial showed that for a first approximation the indicated difference of pressure was proportional to the difference in the areas of the diagrams up to the maximum pressure, and this relation was used to give the correction for cooling. In no case did this correction exceed 10 per cent. of the whole pressure. A new value of the maximum pressure for each mixture was thus obtained, in which the cooling of the vessel was allowed for.

The difference between these corrected results and those derived from calculation, gets less as the proportion of gas in the mixture decreases, ultimately vanishing when the proportion is about 1 of gas to 16 of air.

The conclusions arrived at therefore are that at the higher pressure reached by the best explosive mixture the loss due to cooling is less than the errors of observation, the calculated and actual values differing only on account of dissociation. At the lower pressure given by the weaker mixtures the whole of the loss of pressure is due to cooling. This shows a temperature of about 1,200° C. before carbon dioxide begins to dissociate.

The altered method of firing drew attention to a hitherto unnoticed feature of the diagrams. During some part of the explosion curve the steady rising line is disturbed, sometimes slightly and in regular ripples, at other times very violently. The disturbance lasts for a small fraction of a second, and then disappears, the remainder of the explosion curve being quite smooth. The disturbance is greatest with the richest mixture and a firing tube reaching to the middle of the cylinder In this, and mixtures near to it, the indicator pencil was shot up to a height corresponding to 250 pounds per square inch, in a time too short to be accurately estimated, but which is of the order of a ten-thousandth of a second; after this, only indicator oscillations remained. This indicated rise, which often registered a pressure of 150 pounds per square inch above the steady final pressure, was not entirely due to inertia in the indicator, for when that instrument was arranged to commence its movement at 260 pounds per square inch (this being 45 pounds per square inch above the steady final pressure given by the mixture), the pencil indicated 310 pounds per square inch for the highest point of the diagram. These very big disturbances are associated with unusually quick explosions, and indicate the existence of considerable motion in the cylinder during the explosion.

As the mixtures depart from the most explosive one, the disturbances die down and become small, regular ripples. It now became evident that the interval of time between the beginning of the explosion and the disturbance increases as the length of firing tube increases. With a short tube the ripples occur early in the explosion curve, gradually rising and reaching the top as the tube is lengthened to the middle of the cylinder, after which they occur on the top of the diagram.

In weaker mixtures the ripples are still present, but never reach the top of the diagram, however long the firing tube may be. At the same time the quickest explosions occur with the longest tube (14 inches), and not, as before, with a tube half the length of the cylinder.

In any mixture, whether rich or poor, the time which elapses between the beginning of the explosion and the occurrence of the ripples, is in general found to be proportional to the length of firing tube. From this it seems probable that these disturbances occur when the explosive flame reaches the top of the cylinder, which is also the bottom of the pipe leading to the indicator. If this be so, the above relation between the lapse of time to the ripples and the length of firing tube (which latter is proportional to the amount of gas between the place of firing and the top of the cylinder) indicates that the flame travels through this portion so as to give a constant rate of burning of unit mass throughout the explosion.

It would also appear that where the ripples do not reach the top of the diagram with a firing tube more than half the length of the cylinder, combustion is not completed by the first passage of the flame. With the still slower explosions, the fact that no ripples occur leads to the conclusion that very little motion existed in the cylinder during combustion.

Thermometers.

By C. W., in *Metal Worker*.

Simple and well known as are the little instruments by which we are accustomed to measure ordinary temperatures, it is remarkable that many interesting and instructive scientific facts upon which their construction and use are based are not more generally known.

The term "thermometer" is derived from the Greek words *thermos*, meaning warm, and *metron*, a measure, thus indicating by combination in the word "thermometer," a heat measure, or a device for measuring heat. The mercury thermometer, with which most persons are more or less familiar, consists of a glass bulb and attached sealed tube within which the mercury is free to rise and fall under the influence of heat and cold. These facts are made evident by an examination of a thermometer, but casual observation does not, however, reveal the fact that in the tube above the mercury is a vacuum—*i. e.*, an inclosed space from which the air has been entirely exhausted. In other words, the mercury rises and falls in a vacuum, and while the glass of the bulb and stem also expands under the influence of heat, it does so very much less rapidly than the mercury. Were it otherwise, it would not be possible to utilize the expansion of mercury as a means for indicating temperatures.

Although ordinary mercury thermometers are universally employed to indicate indoor and outdoor temperatures in temperate zones, they are not suitable for use in extremely cold climates, because mercury freezes at a temperature of 40° below zero. Neither are they suitable for the measurement of extremely high temperatures, for mercury volatilizes or boils at a temperature slightly above 357° F. Alcohol or spirit thermometers are used in the frigid zones. The spirits used in such thermometers are extracted in the usual way from wood, potatoes or grain, and are colorless. A red color is usually imparted to the alcohol by the use of aniline dyes, and this is done only for the purpose of rendering the spirits in the tube more easily seen. The addition of the coloring matter interferes somewhat with the sensitiveness of the fluid to atmo-

spheric changes, and consequently is not added to the pure spirits contained in tubes of thermometers used for scientific purposes, for which the greatest accuracy and most minute variations are of great importance.

The length of the glass tube has nothing whatever to do with the accuracy of the indications of the thermometer, the tube being made long only to afford surface for a scale upon which to mark the required number of degrees. The smallest and most sensitive thermometer made, and the one having the greatest number of sub-divisions on the scale, recording fifths of a degree, is that used by physicians for taking temperatures of the human body. The sensitiveness of a thermometer increases with the relative increase in its size. The largest upright recording (Seixas) thermometers used by the United States Signal Service, and at the various meteorological observatories, have the bulbs filled with a mixture of ether and alcohol instead of mercury.

There are three theromometrical scales in general use in different parts ot the world. All English speaking peoples make use of a scale invented by, and called after, a German named Fahrenheit. The Germans tell whether it is cold or not by a scale invented by and called after a Frenchman named Reaumur, while the French, Italians and others ascertain the temperature by a scale founded upon the metric or Centigrade system.

The Centigrade scale is used by scientists almost exclusively as being the most naturally arranged. The divisions being based upon the metric, or decimal system, the figures are much more readily handled than those of the Fahrenheit or Reaumur scale.

With the Fahrenheit scale the zero is placed 32° below the temperature of melting ice; in other words 32° below the freezing point. The zero of the Reamur and Centigrade scales, however, corresponds to the freezing point (32°) of the Fahrenheit scale. Furthermore, the boiling point of water at sea level, which is taken as 212° on the Fahrenheit scale, is placed respectively at 100 on the Centigrade and at 80 on the Reaumur scales. The difference between the three scales may be further explained by saying that the distance on the thermometer scales representing the freezing and boiling points of water is divided into 180 equal parts on the Fahrenheit scale, 100 on the Centigrade scale and 80 on the Reaumur scale, as indicated by the following tabular illustration:

	Water Freezes. Deg.	Water Boils. Deg.
Fahrenheit	32	212
Centigrade	0	100
Reaumur	0	80

In order to convert the reading of a Centigrade thermometer into the corresponding reading of the Fahrenheit scale, the Centigrade reading should be multiplied by 9-5, and 32 should be added to the product. Thus the Fahrenheit reading corresponding to a temperature of 90° C. would be $9\text{-}5 \times 90 + 32 = 194°$ F. On the other hand, Fahrenheit readings may be converted into corresponding Centigrade readings by subtracting 32 and then multiplying them by 5-9. For example, a reading of 203° F. would be $5\text{-}9 \times (203 - 32) = 95°$ C. Reaumur readings may be converted into Fahrenheit readings by multiplying the former by 9-4 and then adding 32, while Fahrenheit readings may be converted into the Reaumer readings by subtracting 32 and then multiplying the Fahrenheit readings by 4-9. Thus 72° R. would be $9\text{-}4 \times 72 + 32 = 194°$ F., while 212° F. would be $4\text{-}9 \times (212 - 32) = 80°$ R.

It is well to bear in mind the methods of conversion above outlined, since valuable data involving Centigrade and Reaumur temperature readings frequently appear in trade publications and elsewhere.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE semi-annual report of the street lighting department of the St. Paul (Minn.) Board of Public Works shows that the street lighting of the city is accomplished through the maintaining of 5,419 lamps, the types of which are as follows: Gas lamps, 2,555; gasoline, 2,510; arcs (electric), 483; miscellaneous, 11.

MR. C. E. CHAPMAN is now in full control of the plants of the Plattsmouth (Neb) Light and Power Company. He could know a little more about gas than he does, but electricians usually improve in that respect when they become better acquainted with the earning powers of the gas end of that trading.

MR. P. J. RHULING has asked that a receiver be appointed to assume charge of the affairs of the South Side Gas Company, of Alexandria, Ind. The concern is of the natural gas type which will shortly go into the artificial end of the business. The queer thing about the application, though, is, even on the face of Mr. Rhuling's papers, that under existing conditions the South Side Company is making money.

MR. E. S. PINCKNEY, formerly in charge of the "plants" of the Steelton (Pa.) Home Gas Company, has been appointed Manager of the Sag Harbor (L. I.) Light, Heat and Power Company.

MR. A. B. FRANTZ has been appointed Assistant Superintendent to the Chambersburg (Pa.) Gas Company, succeeding Mr. H. M. Bixby, who returns to Bloomington, Ills., there to assume a post of responsibility.

GEN. W. H. HART has petitioned the Town Trustees of Palo Alto, Cal., for the right to there operate a gas works. If he succeeds he will be fortunate, as the Palo Alto public are and have been trying "to support" a municipal electric lighting outfit for quite a while.

AT a session of the Syracuse (N. Y.) Chemical Society, held last Friday, the lecturer of the evening was Mr. Thomas Littlehales, whose topic was the "Manufacture of Illuminating Gas," a subject that Mr. Littlehales should be able to fluently discuss.

AT the annual meeting of the Elizabethtown (N. J.) Gas Light Company the re-elected Directors were: John Kean, Julian H. Kean, H. F. Kean, James Maguire and Alexander L. Kean.

THE Coast Gas Company, of Belmar, N. J., has again declared its intention to hook up Manasquan for a gas supply at an early date. Shortage of pipe deliveries is put up for the failure to have sent a gas supply to Sea Girt and Manasquan last summer.

WHAT do you think of this? The story is from a recent issue of the Brooklyn (N. Y.) *Daily Eagle:* "Two suits for damages arising out of the breaking of a gas main of the Brooklyn Union Gas Company will shortly begin in the Supreme Court. Justice Dickey has appointed James J. Coady, of 349 Sackett street, guardian *ad litem* of his infant son, James C. Coady, in the suit he will bring against the gas company. Considerable interest will no doubt attach to the trial, as the suit will be urged because of certain incidents connected with the child's birth. It is alleged that while employees of the gas company were at work in front of the Coady residence on Oct. 26 last one of the gas mains burst, filling the Coady house with an overpowering odor to which Mrs. Coady succumbed. The next day Mrs. Coady gave birth to the child, and it is alleged that its life was only saved by an operation. The second suit is that of Louise Martin, 3 years old, who will bring suit, through her father, Christopher Martin. It is alleged that the gas also entered the Martin home and overcame the child."

A CORRESPONDENT in Cincinnati forwards the following: "The last official act regarding the resignation of General Andrew Hickenlooper, as President of the Cincinnati Gas and Electric Company, took place some days ago when Messrs. W. A. Goodman, Casper H. Rowe and Charles P. Taft presented to the General. at his home in Dayton street, an illuminated testimonial from the Board of Directors. The passing of so able and distinguished a man from the acuive circles of business to the quiet and rest of home was one of the important events of this year in the affairs of Cincinnati. Following is the text of the official communications that passed between General Hickenlooper and his former business associates in the Cincinnati Gas and Electric Company:

"CINCINNATI, May 18, 1903.

"To the Board of Directors of the Cincinnati Gas and Electric Company:

"Gentlemen—In consequence of continued ill health, which will prohibit for an indefinite period the performance of my official duties, I have the honor to herewith tender to you my resignation as President of the Cincinnati Gas and Electric Company.

"It is with great regret that I find it necessary to sever the very pleasant personal and official relations that have existed, for a period of over 30 years, between myself, the stockholders and the several boards which have directed the affairs of this Company.

"The regret, however, is lessened by the knowledge that in thus retiring I leave as my successor a man so competent, capable and experienced as is your present Vice-President—Norman G. Kenan.

"He came into the employment of this Company 35 years ago, and

has since, by constant and continued application to duty, risen step by step to his present position, to which he was elected in 1892; since which time he has been my most able coadjutor, laboring day and night with a single-minded devotion to promote the best interests of this Corporation during the most perilous and important period of its history. He is not only thoroughly qualified as a technical gas and electrical engineer, but he has the additional advantage of long experience in dealing with public and municipal affairs.

"It is an additional pleasure that in leaving you I do so when not only have our gas interests been firmly established, but the long and bitter rivalry existing between the various electrical companies during the past 15 years has been happily terminated by the recent consolidation, which leaves your Corporation occupying the unique position of being the only one which singly serves an entire city.

"As one of the largest individual stockholders of the Company, it will be in the future, as it always has been in the past, my pride and pleasure to further in every way the welfare of this Corporation, and to that end I shall be glad to give such aid or assistance as director, or as advisor, or co-operator with the Board or its President at all times as my health will permit.

"Under these favorable auspices there remains for me but to invoke for the Company and its managers the utmost success, and to proffer my fervent hopes for their continued prosperity.

Very truly yours, A. HICKENLOOPER."

"The resolutions adopted by the Board of Directors of the Cincinnati Gas and Electric Company May 28, 1903, follow: On motion of Mr. Goodman, seconded by Mr. Rowe, the communication from General Andrew Hickenlooper was ordered to be spread upon the minutes and filed, and the following preamble and resolutions were adopted:

"'*Whereas*, General Hickenlooper has, for reasons therein set forth, tendered his resignation as President of this Board; and,

"'*Whereas*, His illness is primarily due to overwork in the Company's interests, and his resignation is tendered that he can retire from active duties so that he may find restoration of health; therefore,

"'*Resolved*, That we hereby reluctantly and regretfully accept his resignation as President of this Company, which he has managed with such pre-eminent and extraordinary ability as its Vice-President and President during the past 31 years.

"'*Resolved*, That a committee of three be appointed to draft suitable resolutions, expressive of the high esteem in which he is held by this board, individually and collectively, and their appreciation of his self-sacrificing devotion to duty and his ability displayed as to engineering and management, whereby this Company possesses a model gas and electric plant and equipment.

"'*Resolved*, That a copy of said resolutions, when adopted, be suitably engraved and signed by the members of the board and the officers of the Company and presented to General Hickenlooper as a testimonial of the high esteem in which he is held by this board, its officers and the stockholders of the Company.

"'*Resolved*, That the committee recommend such further action in the premises as it may deem expedient to give evidence of our high regard and the inestimable value of his services.'"

"The illuminated resolutions as presented to the General are:

"CINCINNATI, June 10, 1903

"Your committee, appointed by the board at a special meeting held May 28, 1903, to draft suitable resolutions expressive of the sentiment of the board and its officers toward General A. Hickenlooper, submit the following:

"'*Resolved*, That we reluctantly accept the resignation of General A. Hickenlooper as President of the Cincinnati Gas and Electric Company. His management of the business details of the Company was performed with conscientious care and self-sacrificing devotion to duty, and he has displayed unusual ability as an engineer during the 31 years of active service, first as Vice-President and later as its President.

"'His work has given to this Company a model gas and electric plant, which cannot be excelled in labor-saving devices, in utilization of waste products and in economy of operation. Many of the improvements introduced by General Hickenlooper in the Cincinnati works have come into general use and practice.

"'He has also written many arguments and papers bearing upon the questions of competition, the relationship of municipalities to quasi-public corporations, and other topics of value to the lighting industry, which have become extensively quoted and cited as authorities in this country and Europe.

"'This tribute of worth and appreciation we most gladly extend to General Hickenlooper.

"'*Resolved*, That a copy of these resolutions be suitably engraved, signed by the members of the board and its officers, and presented to General A. Hickenlooper as a testimonial of the high esteem in which he is held by this board, its officers and the stockholders of this Company.

"'W. A. GOODMAN,
"'CASPER H. ROWE,
"'CHARLES P. TAFT,
"'Committee.'"

MESSRS. EDWARD M. DEAN & CO., of Grand Rapids, Mich., are now in complete control of the properties of the Citizens Gas Light Company, of Vincennes, Ind., and the Vincennes Electric Light and Power Company. The new corporate name of the merged properties is the Vincennes Light and Power Company, and its affairs are to be managed by Mr. H. B. Wales, of Grand Rapids.

HERE'S one from Fall River, Mass., which a well-known Eastern gas man asserts is all-to-the-truth:

"The Fall River Gas Company complained to the Eastern station police a few days ago that a tool chest left by workmen on Oak Grove avenue had been broken into. Three rubber bags were stolen. Officer McGraw was ordered to investigate and subsequently discovered that it was the work of youngsters. They had taken the rubber bags, and putting them in leather cases used them for footballs. and, as one of the boys remarked, 'Dey was great footballs, too.' The articles were recovered and brought to the station, where Captain Feeney turned them over to the Company's representatives. The boys were of such tender years that there was no desire to prosecute, but they were given a little talk that will probably do them much good."

THE proprietors of the Milford (Mass.) Gas Light Company have established a minimum service rate per month of 25 cents.

IT is said that Themas Rankin, of Chicago, and his associates, will construct a gas plant at Boise City, Idaho.

THE plant of the Beaver Dam (Wis.) Gas Company is now in successful operation. Construction work thereon was started about midsummer.

THE Mauch Chunk (Pa.) gas works are to be overhauled, which rehabilitation has long been delayed.

AT the annual meeting of the shareholders in the Madison County (N. Y.) Gas and Electric Company the following Directors were elected: Lawrence Barnes, New York, N. Y.; S. N. Blake, Providence, R. I.: C. W. Keiner, W. E. Douglas, F. Walters and W. H. Patten.

THE Laclede Gas Light Company, of St. Louis, Mo., has made an important purchase of property on Choteau avenue, adjoining the land on which the Company's large holder stands.

THE Burlington (Vt.) Gas Light and Power Company's executive staff is now enjoying comfort and freedom in the new office quarters on Winooski street.

THE following bit of information, respecting how liberal "real reform" city administrations can be, is from *Engineering News:* A four-legged assistant to a city engineer in the Central West has been the indirect cause of no little trouble. It appears from a local paper that when the engineer was elevated from the position of assistant engineer to city engineer he offered to dispense with an assistant, as ordinarily understood, if the city would provide him with a horse and buggy. To this proposition the city fathers would not agree, but they did consent to pay for the feed of a horse if the city engineer would buy both horse and buggy. (The report does not say who paid for axle grease.) For some 5 years a horse served as a substitute for an assistant, "under republican and democratic administrations." Suddenly the mayor and the finance committee of the city council claimed that it was improper to allow the bills for the feed of the horse. The cause of this, the engineer states, was that he had stopped buying feed at the mayor's store. We leave to our readers the task of drawing a moral to fit this homely, but doubtless true, story.

THE AMERICAN GAS LIGHT JOURNAL

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PROPRIETORS.

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OHIO GAS LIGHT ASSOCIATION.

NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, NOVEMBER 23, 1903.

The Market for Gas Securities.

The dealings in local gas shares were on a very small scale during the week, but the tendency was decidedly toward higher figures, save in one instance, and in that the art of manipulation was clearly traceable. Consolidated closed to-day (Friday) at 177½ to 178½, and the demand for it was good. The output of the Company is really in excess of the corresponding period for 1902, when the effects of the coal miners' strike were clearly noticeable. The pegging game referred to leaned towards Mutual, which was offered at 300, according to the quotations, but the best recorded bid was 260. If the figures were 300 bid, offered at 360, truth would have had a better chance. City gas bonds of any accredited issue are very hard to get.

Brooklyn Union is back nominally to 180 to 205. There is little doubt that the one-sixth issue of its total indebtedness, as proposed, will carry. This means an issue of $5,000,000 debenture bonds, at par, convertible eventually into stock at par.

Peoples, of Chicago, more than holds its own, and Washington (D. C.) shows no change.

There is quite a good demand for Laclede (St. Louis) preferred. Baltimore Consolidated is steady.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

NOVEMBER 23.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	177½	178½
Central Union, Bonds, 5's.	3,000,000	1,000	104	106
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	118	120
Metropolitan	658,000	..	108	112
Mutual	3,500,000	100	260	300
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co. .. Bonds, 5's	11,000,000	1,000	103	105
Northern Union, Bonds, 5's.	1,250,000	1,000	105	106½
New York and East River Bonds 1st 5's	3,500,000	1,000	108	106
" 1st Con. 5's	1,500,000	..	109	111
Standard	5,000,000	100	135	140
Preferred	5,000,000	100	155	170
Bonds, 1st Mortgage, 5's	1,500,000	1,000	116	117
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	180	205
" " Bonds (5's)	15 000,000	1,000	119	119½
Bay State	50,000,000	50	⅛	¼
" Income Bonds	2,000,000	1,000	.	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	4	5
" " Bonds, 5's	5,256,000	1,000	73	76
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co..	29,500,000	100	96	96½
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	101	101½
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	88¼	89¼
Preferred	3,026,500	100	107½	109
Consumers, Jersey City Bonds	600,000	1,000	100	102
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore	11,000,000	100	60	62
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's.	1,000,000	..	..	..
Equitable, 1st 6's.	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	86	90
Consolidated G. & E. Co.'s. Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	87	95
" Prior Lien 5's	5,603,000	1,000	99¼	100
Detroit Gas Co., 5's	961,000	1,000	77	79
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	15	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	50	65
" Bonds, 6's	2,650,000	..	103½	106½
Jackson Gas Co	250,000	50	73	75
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	79	90
Preferred	2,500,000	100	89	..
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100	..	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	135	140
Madison Gas & Elec. Co. " 1st Mtg. 5's	350,000	1,000	107½	108½
" 6 per cent. scrip, due 1910	100,000	25	85	87
Montreal, Canada	2,000,000	100	218	184¾
Nashville Gas Lt. Co.	1,000,000	100	110	..
Newark, N. J., Con. Gas Co.	6,000,000	..	56	58
Bonds, 6's	4,600,000	..	105	105¾
New Haven	1,000,000	25	230	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	93¾	94
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	..
Rochester Gas & Elec. Co..	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	15,800,000	100	67	67¼
St. Joseph Gas Co. " 1st Mtg. 5's	751,000	1,000	92	96½
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	113½	115
General Mortgage, 5's	2,465,000	1,000	92	93
Syracuse, N. Y.	1,975,000	100	46	48
Bonds	2,047,000	1,000	94	96
Washington, D. C	2,600,000	20	290	291
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	.	..	..
Wilmington, Del.	600,000	50	282	..

Advertisers' Index.

GAS ENGINEERS. Page

A. E. Boardman, New York City 832
Baxter & Young, Detroit, Mich 832
B. E. Cholar, St. Louis, Mo 818
David Leavitt Hough, New York City 832
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 824
Frank D. Moses, Trenton, N. J 818
Fred. Bredel Co., Milwaukee, Wis 820
Frederic Egner, Washington, D. C 816
Geo. R. Rowland, New York City 822
Humphreys & Glasgow, New York City 833
Kerr Murray Mfg. Co., Fort Wayne, Ind. 832
The Gas Machinery Co., Cleveland, O 819
The Jeffrey Manufacturing Co., Columbus, O. 830
The Western Gas Construction Co., Fort Wayne, Ind. 800
United Gas Improvement Co., Philadelphia, Pa. 827
Wm. Henry White, New York City 835

GAS WORKS APPARATUS AND CONSTRUCTION.

A. E. Boardman, New York City 832
Bartlett, Hayward & Co., Baltimore, Md. 833
Baxter & Young, Detroit, Mich. 832
Christopher Cunningham, Brooklyn, N.Y. 829
Connelly Iron Sponge and Governor Co., New York City 783
Continental Iron Works, Brooklyn, N. Y. 834
Cruse-Kemper Co., Philadelphia, Pa. 819
Davis and Farnum Mfg. Co., Waltham, Mass. 832
Delly & Fowler, Philadelphia, Pa. 836
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 824
Frank D. Moses, Trenton, N. J 818
Fred. Bredel Co., Milwaukee, Wis. 820
G. Shepard Page's Sons, New York City 832
Humphreys & Glasgow, New York City 833
Isbell-Porter Company, New York City 834
Kerr Murray Mfg. Co., Fort Wayne, Ind. 832
Lloyd Construction Co., Detroit, Mich. 822
Logan Iron Works, Brooklyn, N. Y. 836
Quintard Iron Works, New York City 833
R. D. Wood & Co., Philadelphia, Pa. 834
Riter-Conley Mfg. Co., Pittsburg, Pa. 835
Stacey Mfg. Co., Cincinnati, O. 835
The Connersville Blower Company, Connersville, Ind. 837
The Gas Machinery Co., Cleveland, O. 819
The Jeffrey Manufacturing Co., Columbus, O. 830
The Western Gas Construction Co., Fort Wayne, Ind. 800
United Gas Improvement Co., Philadelphia, Pa. 827

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md. 833
B. E. Cholar, St. Louis, Mo. 818
Economical Gas Apparatus Construct'n Co, Toronto, Ont. 824
Humphreys & Glasgow, New York City 833
The Gas Machinery Co., Cleveland, O. 819
The Western Gas Construction Co., Fort Wayne, Ind. 800
United Gas Improvement Co., Philadelphia, Pa. 827

SCRUBBERS AND CONDENSERS.

Continental Iron Works, Brooklyn, N.Y. 834
Economical Gas Apparatus Construct'n Co., Toronto, Ont. 824
Kerr Murray Mfg. Co., Fort Wayne, Ind. 832
Logan Iron Works, Brooklyn, N. Y. 836
R. D. Wood & Co., Philadelphia, Pa. 834
Riter-Conley Mfg. Co., Pittsburg, Pa. 835
Stacey Mfg. Co., Cincinnati, O. 835
The Gas Machinery Co., Cleveland, O. 819
The Western Gas Construction Co., Fort Wayne, Ind. 800

PRODUCER POWER PLANTS.

Economical Gas Apparatus Construct'n Co., Toronto, Ont. 824
R. D. Wood & Co., Philadelphia, Pa. 834

TAR AND CARBONIC ACID EXTRACTOR.

Economical Gas Apparatus Construct'n Co.,Toronto,Ont. 824
Stacey Mfg. Co., Cincinnati, O. 835
The Gas Machinery Co., Cleveland, O. 819
The Western Gas Construction Co., Fort Wayne, Ind. 800

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich. 820
The Gas Machinery Co., Cleveland, O. 819
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(*Continued on page* 816.)

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(*Continued from page* 815.)

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Welsbach Street Lighting Co., New York and Phila.... 826

PURIFIERS.

Connelly Iron Sponge and Governor Co., New York City. 783
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 832
R. D. Wood & Co., Philadelphia, Pa..... 834
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Connelly Iron Sponge and Governor Co., New York City 783

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Economical Gas Apparatus Construct'n Co., Toronto, Ont. 824
Isbell-Porter Co., New York City..... 834
Kerr Murray Mfg. Co., Fort Wayne, Ind 832
Ludlow Valve Manufacturing Co., Troy, N.Y..... 821
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Kerr Murray Mfg. Co., Fort Wayne, Ind..... 832
Logan Iron Works, Brooklyn, N.Y..... 836
R. D. Wood & Co., Philadelphia, Pa..... 834
Riter-Conley Mfg. Co., Pittsburg, Pa..... 836
Stacey Mfg. Co., Cincinnati, O..... 835

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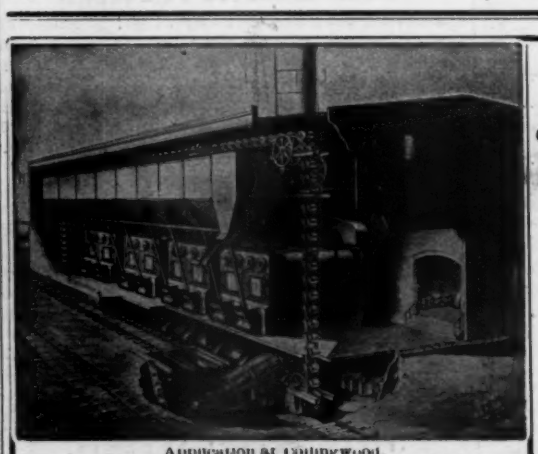

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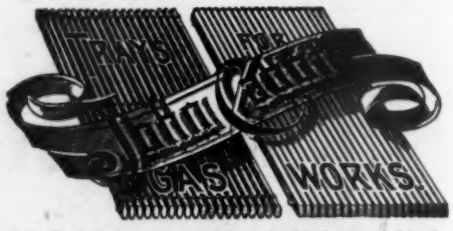

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By G. LIECKFELD, C.E. Translated with Permission of the Author, by GEO. M. RICHMOND, M.E. Price, $1.00.

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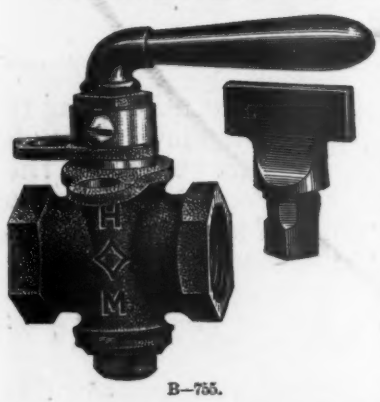

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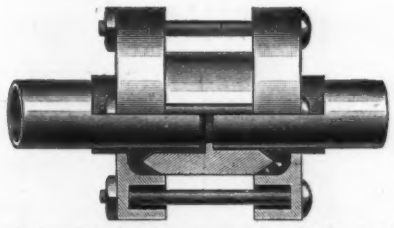
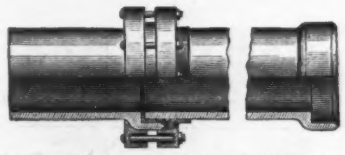


Insulating Coupling for Wrought Iron Pipe. Style 5.



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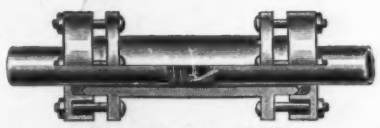
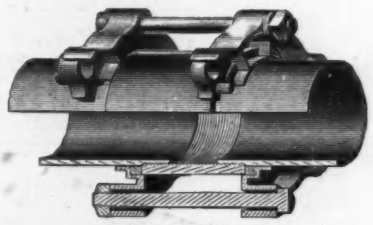
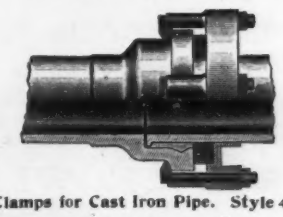


Regular Sleeve. Style 2.



Clamp. Style 4.



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Pipe Couplings, Sleeves, Clamps, Crosses, Tees and Ells.

My Insulating Coupling prevents the destruction of pipe by electrolytic action, in either water or gas lines.

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Coal Gas Condensing and Scrubbing Apparatus.
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The Lloyd System of Valve Connections.
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Economize Heat in Water Gas Plants,

BY UTILIZING A

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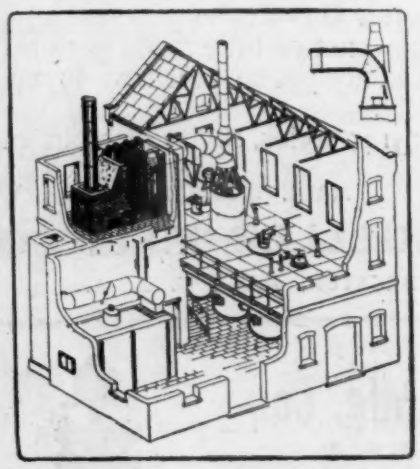

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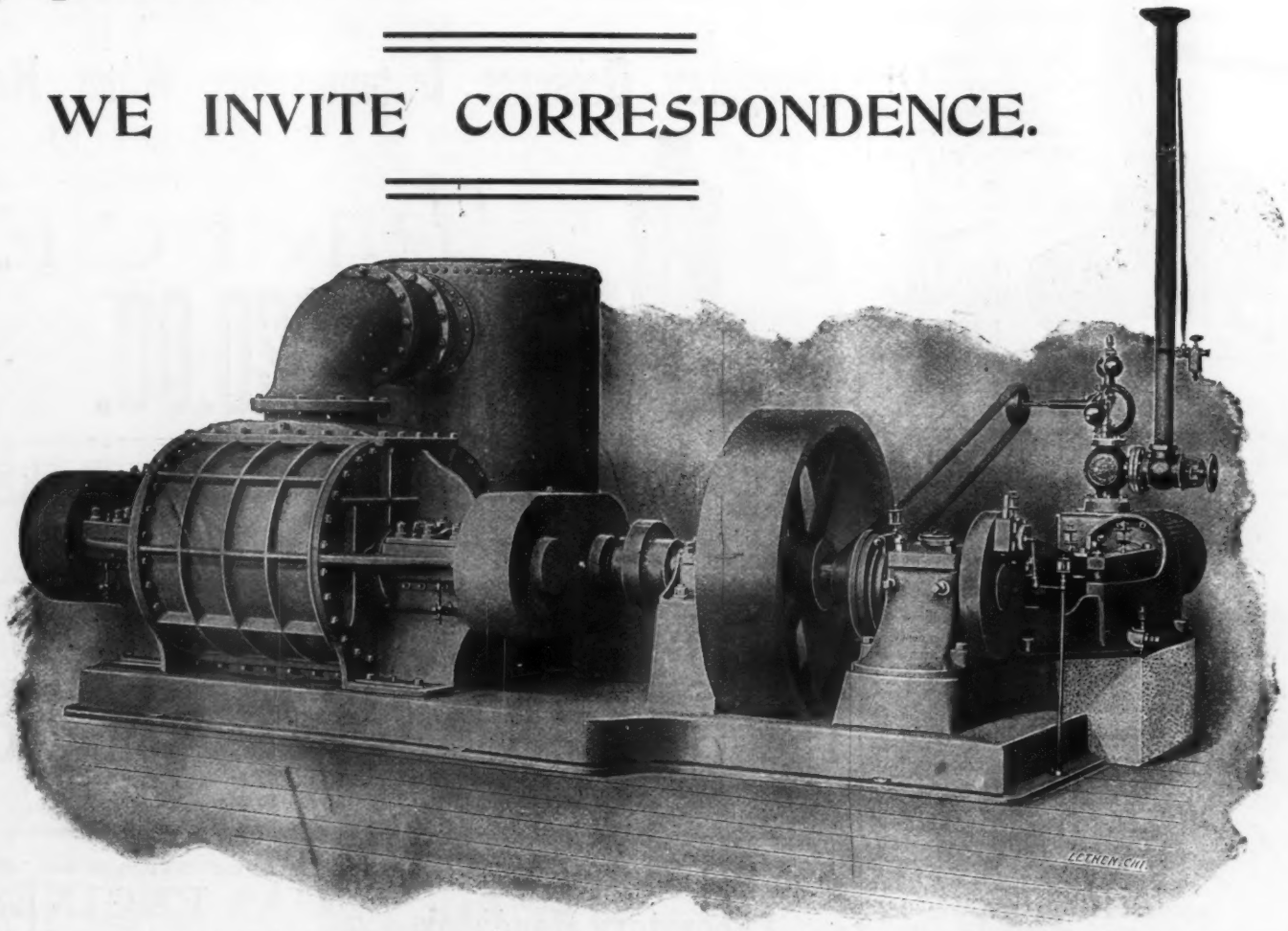

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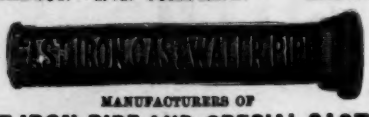

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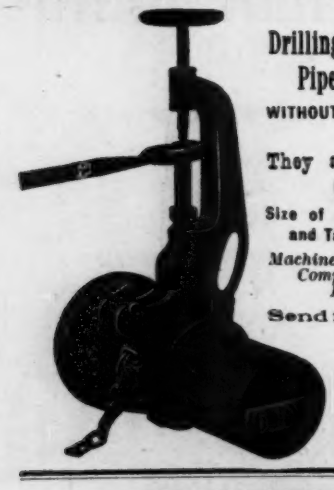

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For Shutting Off Gas in Mains

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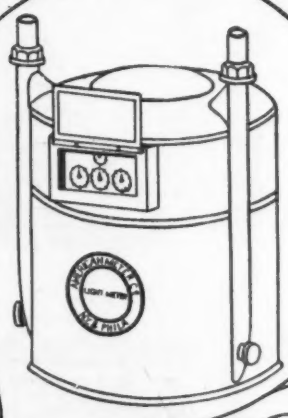
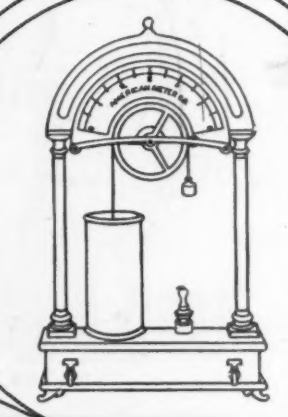
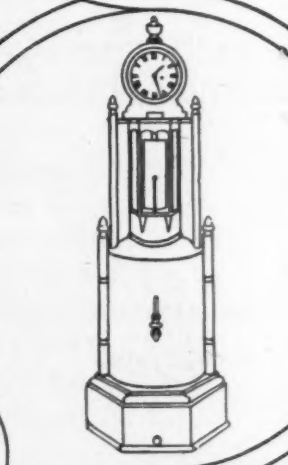
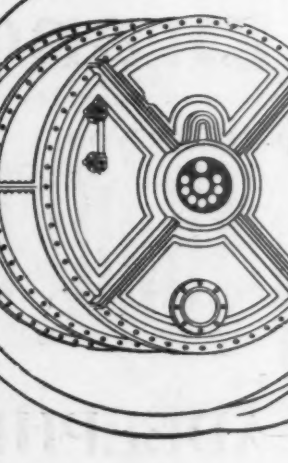








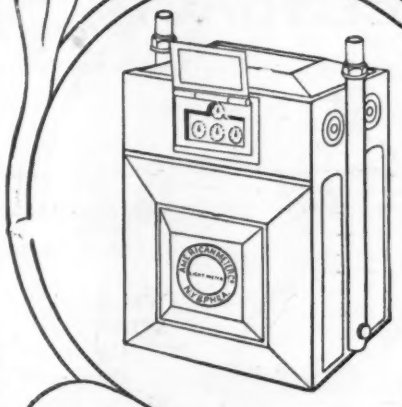
PUBLIC LIGHTING TABLE.

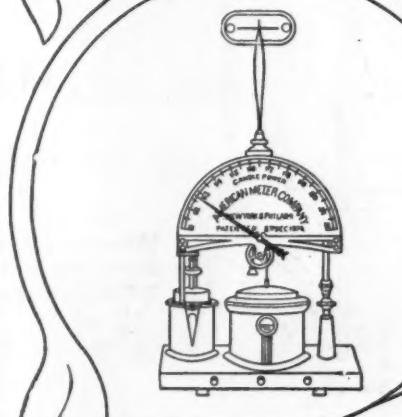
DECEMBER, 1903.

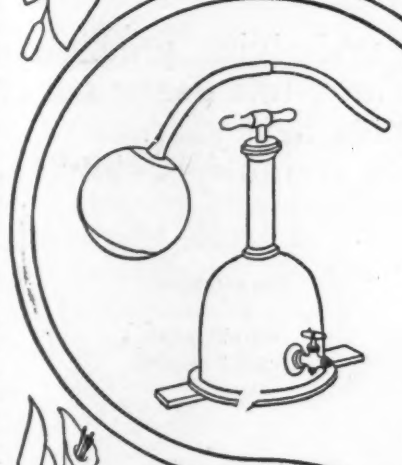
Day of Week.	Date.	Table No. 1. FOLLOWING THE MOON. Light.	Extinguish.	Table No. 2. NEW YORK CITY. ALL NIGHT LIGHTING. Light.	Extinguish.
				P.M.	A.M.
Tue.	1	3.30 AM	6.00 AM	4.20	6.10
Wed.	2	4.30	6.00	4.20	6.10
Thu.	3	No L.	No L.	4.20	6.15
Fri.	4	No L. FM	No L.	4.20	6.15
Sat.	5	No L.	No L.	4.20	6.15
Sun.	6	5.00 PM	8.00 PM	4.20	6.15
Mon.	7	5.00	9.00	4.20	6.15
Tue.	8	5.00	10.10	4.20	6.15
Wed.	9	5.00	11.20	4.20	6.15
Thu.	10	5.00 LQ	12.30 AM	4.20	6.20
Fri.	11	5.00	1.40	4.20	6.20
Sat.	12	5.00	2.40	4.20	6.20
Sun.	13	5.00	3.40	4.20	6.20
Mon.	14	5.00	4.50	4.20	6.20
Tue.	15	5.00	6.20	4.20	6.20
Wed.	16	5.00	6.20	4.20	6.20
Thu.	17	5.00	6.20	4.20	6.20
Fri.	18	5.00 NM	6.20	4.20	6.20
Sat.	19	5.00	6.20	4.20	6.20
Sun.	20	5.10	6.20	4.20	6.20
Mon.	21	5.10	6.20	4.20	6.20
Tue.	22	5.10	6.20	4.20	6.20
Wed.	23	8.20	6.20	4.20	6.20
Thu.	24	9.10	6.20	4.20	6.25
Fri.	25	10.10	6.20	4.20	6.25
Sat.	26	11.10 FQ	6.20	4.20	6.25
Sun.	27	12.10 AM	6.20	4.20	6.25
Mon.	28	1.10	6.20	4.20	6.25
Tue.	29	2.10	6.20	4.20	6.25
Wed.	30	3.10	6.20	4.20	6.25
Thu.	31	4.20	6.20	4.20	6.25

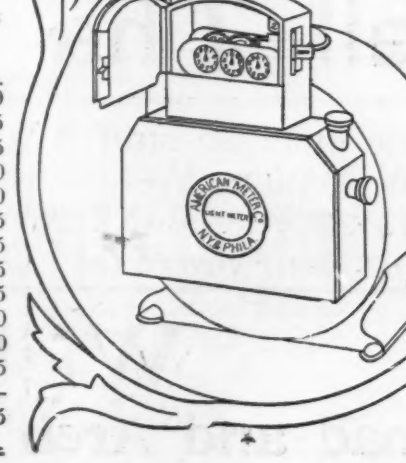
TOTAL HOURS LIGHTING DURING 1903.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	245.00	January	423.20
February	192.00	February	355.25
March	201.00	March	355.35
April	167.20	April	298.50
May	152.00	May	264.50
June	131.00	June	234.25
July	140.40	July	243.45
August	156.20	August	280.25
September	171.20	September	321.15
October	198.20	October	374.30
November	216.30	November	401.40
December	232.10	December	433.45
Total, yr.	2203.40	Total, yr.	3987.45









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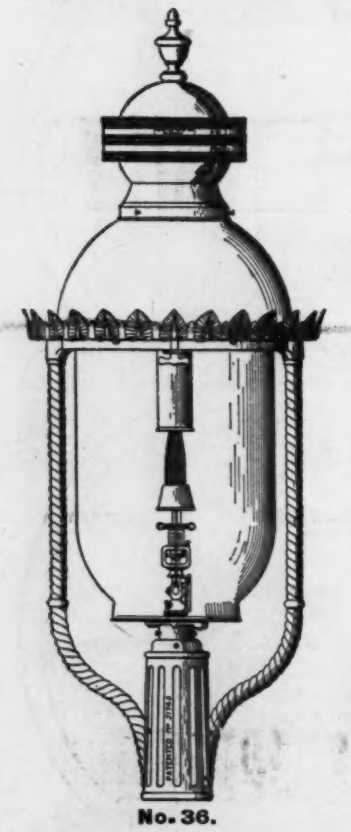
.... OF AMERICA ....



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POINTS OF MERIT:

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IT LIGHTS THE STREET.

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No. 38.

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The formula is simple-

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Sell The Welsbach Brands.

The imitation stuff is bad for the customer---which is bad for you.

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And your profit isn't merely dollars and cents.

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For the Months Ending October 15, 1903, has been Awarded Contracts in the Following Places for

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Baltimore, Md.	**Chester, Pa.**	**Savannah, Ga.**
Chicago, Ills.	**Lynn, Mass.**	**New York** (Central Union Co.)
Amesbury, Mass.	**Newark, N. J.**	**Cicero, Ills.**
Aberdeen, S. D.	**Washington, D. C.**	**Chicago** (Ogden Co.)
Winsted, Conn.	**Boone, Ia.**	**Easton, Pa.**
Canon City, Col.	**Pueblo, Col.**	**Lawrence, Mass.**
Schenectady, N. Y.	**Charlotte, N. C.**	**Council Bluffs, Ia.**
Hagerstown, Pa.	**Fall River, Mass.**	**Chattanooga, Tenn.**
Malden, Mass.	**Duluth, Minn.**	**Tuckerton, N. J.**
Bridgeport, Conn.	**New York** (Mutual Co.)	**Springfield, O.**
Albert Lea, Minn.	**Waltham, Mass.**	**Easton, Pa.** (2d contract).
Brooklyn, N. Y.	**Dover, Del.**	**Mobile, Ala.**

TOTAL DAILY SETS TO OCTOBER 15, 1903, ... 55
TOTAL DAILY CAPACITY, ... 56,600,000 cubic feet.
TOTAL SETS TO DATE, ... 502
TOTAL DAILY CAPACITY, ... 356,280,090 cubic feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

Established 1858. Incorporated 1890.
CHAS. E. GREGORY, Prest. DAVID R. DALY, V.-Prest. & Treas.
H. D. ABERNETHY, Sec.

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Manufacturers of { GAS RETORTS . .
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Also for Free-Firing and Full and Half-Depth Regenerative Benches, for Burning either Coal or Coke in the Furnaces.

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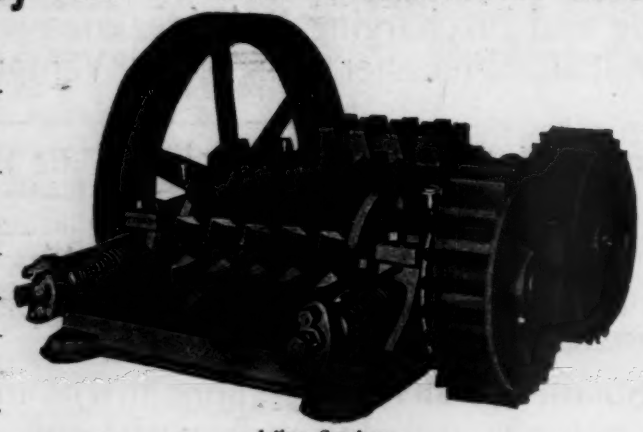

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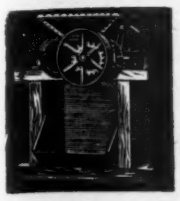

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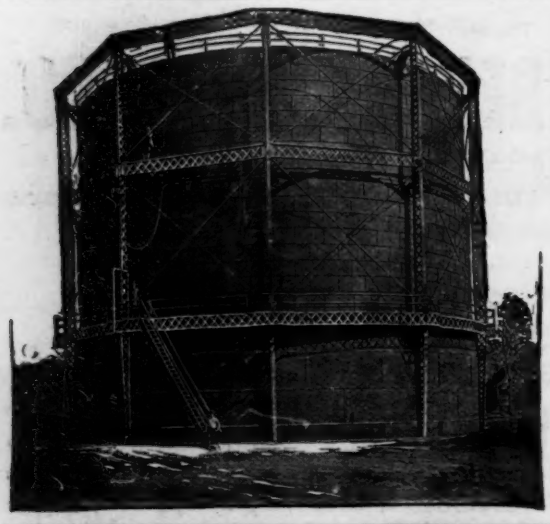

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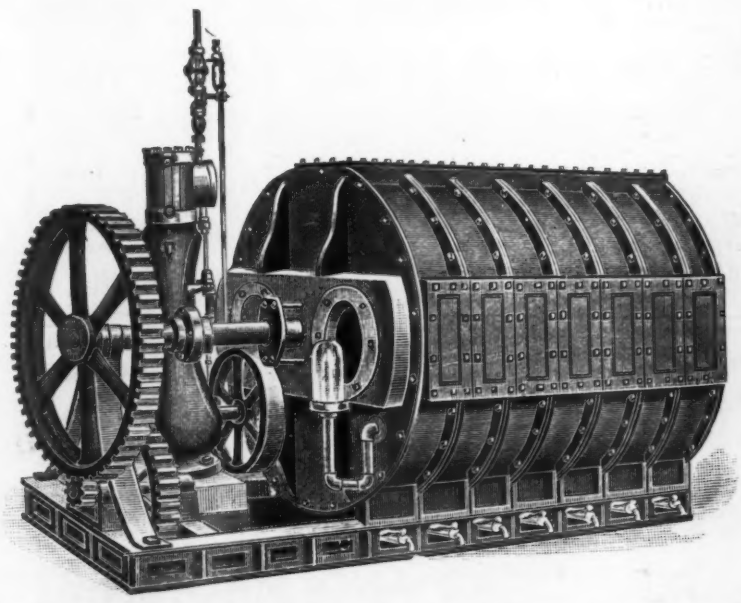

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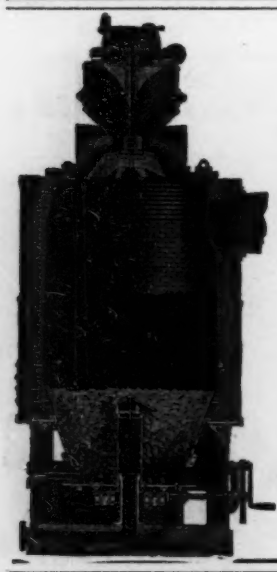

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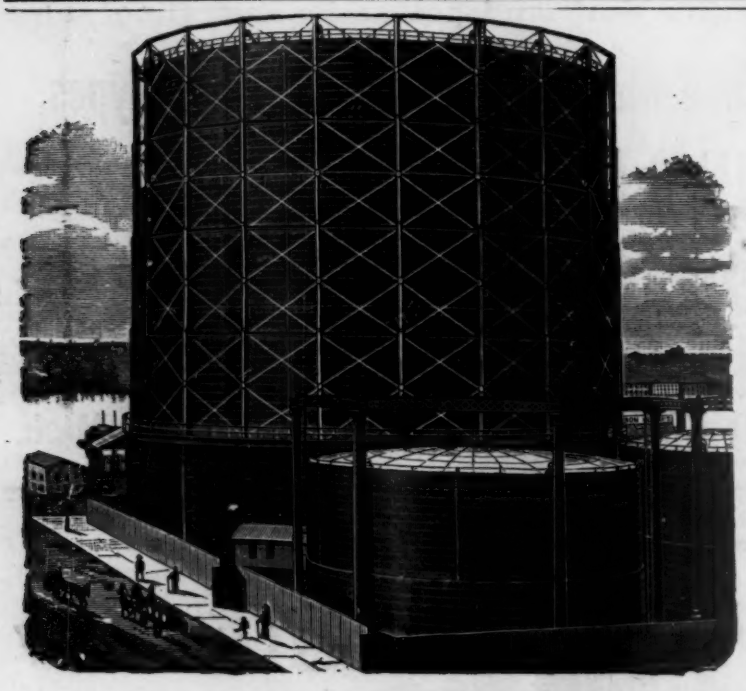

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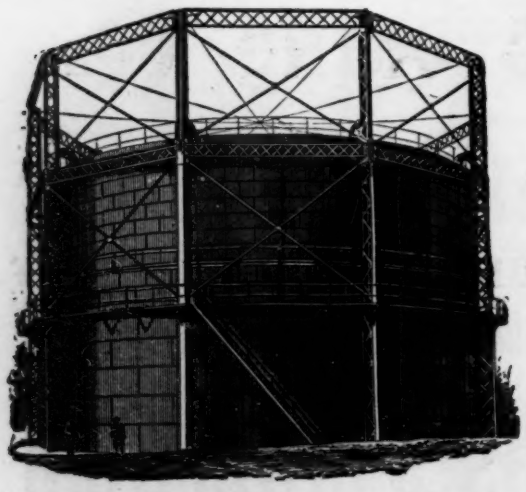

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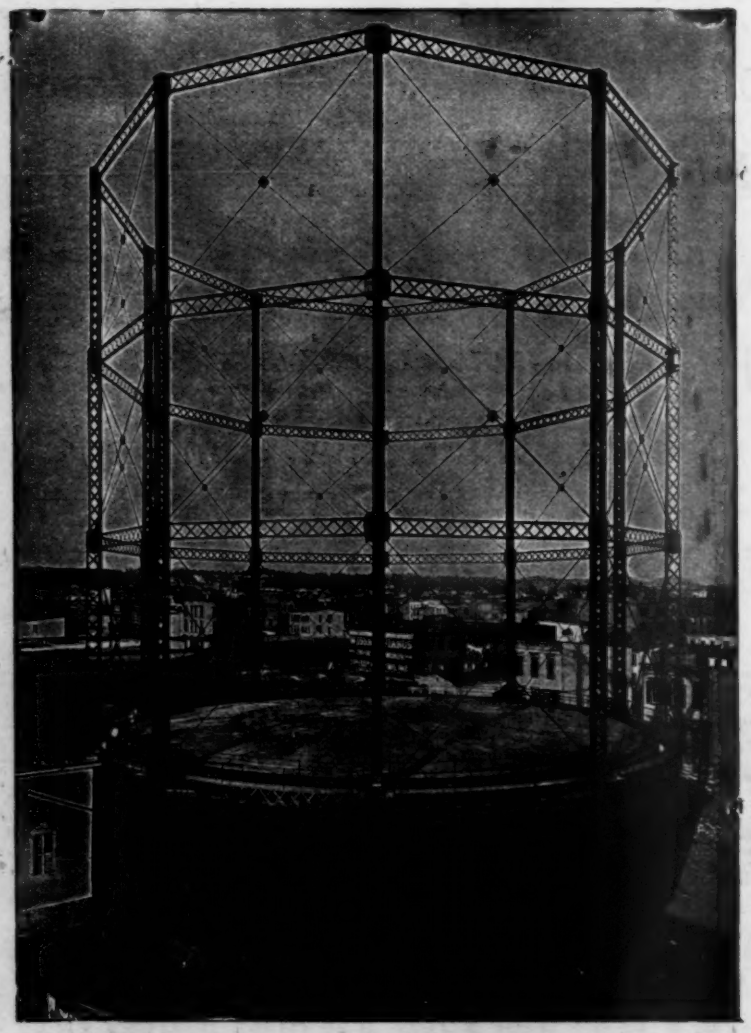

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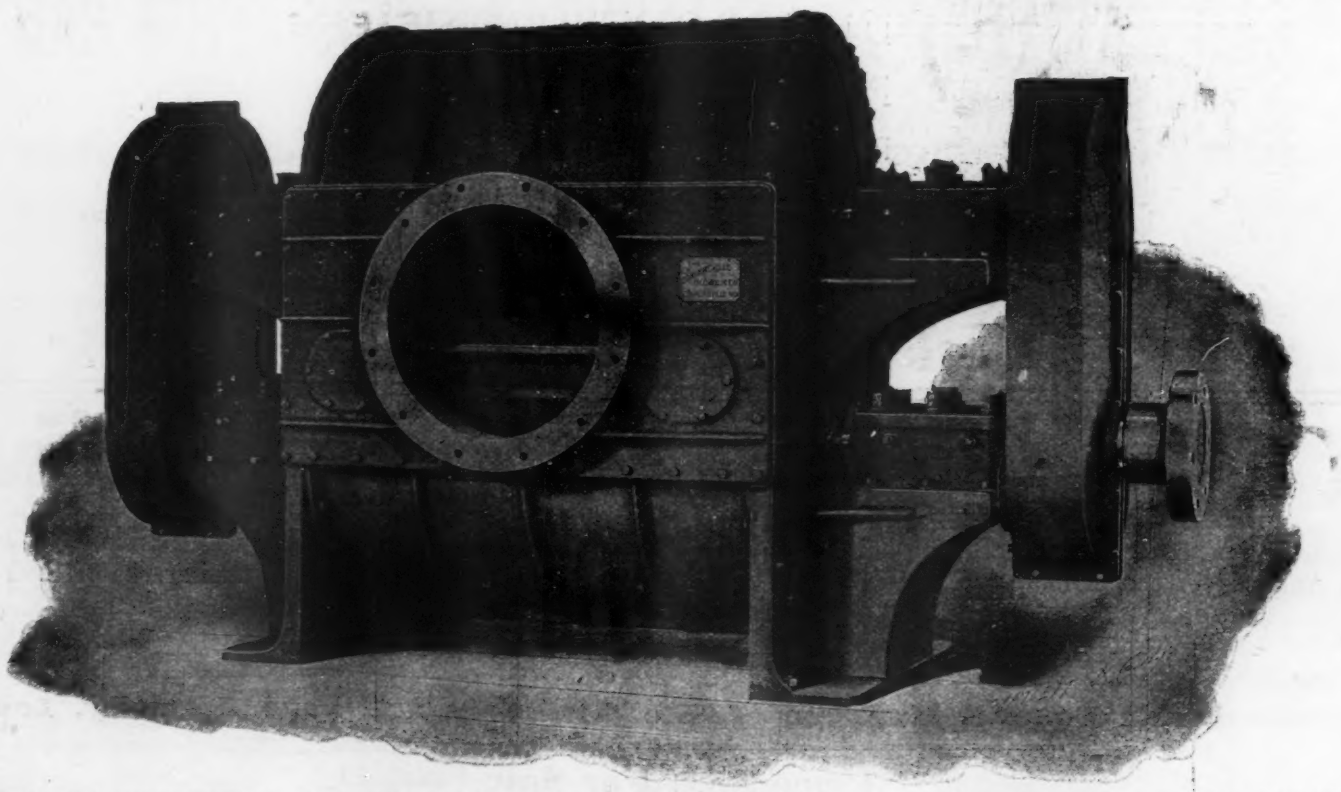

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